12. SEVERE WINTER WEATHER

12.1 Hazard Profile

12.1.1 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 and are typically accompanied by low temperatures. According to the National Severe Storms Laboratory (NSSL), the following three basic components are needed to make a winter storm (NOAA 2021):

- Below freezing temperatures (i.e., 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.
- Moisture to form clouds and precipitation, such as air blowing across a large lake or the ocean.

Some winter storms can immobilize an entire region, while others might only affect a single community. The aftermath of a winter storm can impact a community or region for days, weeks, or even months, potentially causing cold temperatures, flooding, storm surge, closed or blocked roadways, downed utility lines, and power outages. Hudson County's winter storms include, but are not limited to heavy snow, blizzards, sleet, ice storms, and nor'easters.

HEAVY SNOW

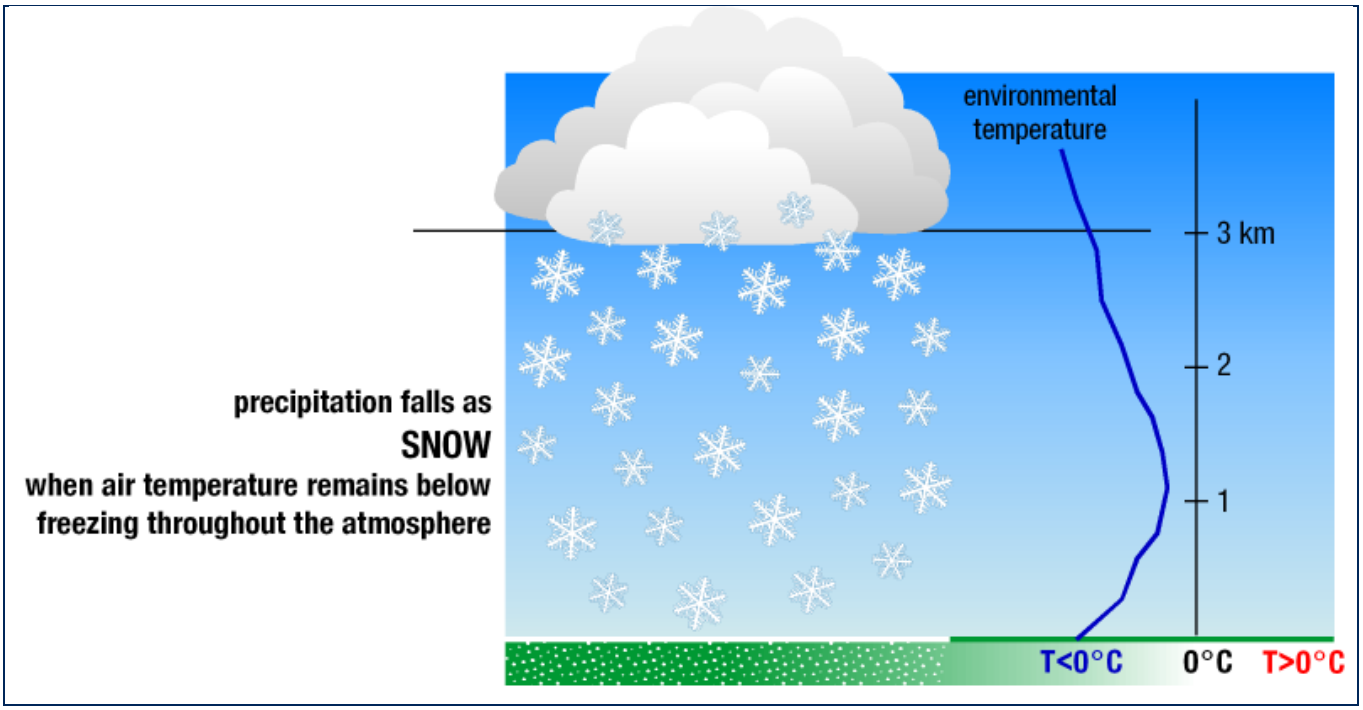
Snow is precipitation in the form of ice crystals (NSIDC 2024). It originates in clouds when temperatures are below the freezing point (32 °F) and water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals, which then fall to the earth. Snowflakes are clusters of ice crystals that form from a cloud. Figure 12-1 depicts snow creation.

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 0.25 miles or less, as the predominant conditions over a three-hour period (NOAA 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 (NOAA NWS n.d.).

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).

Figure 12-1. Snow Creation



Source: NOAA 2023

Ice Storms

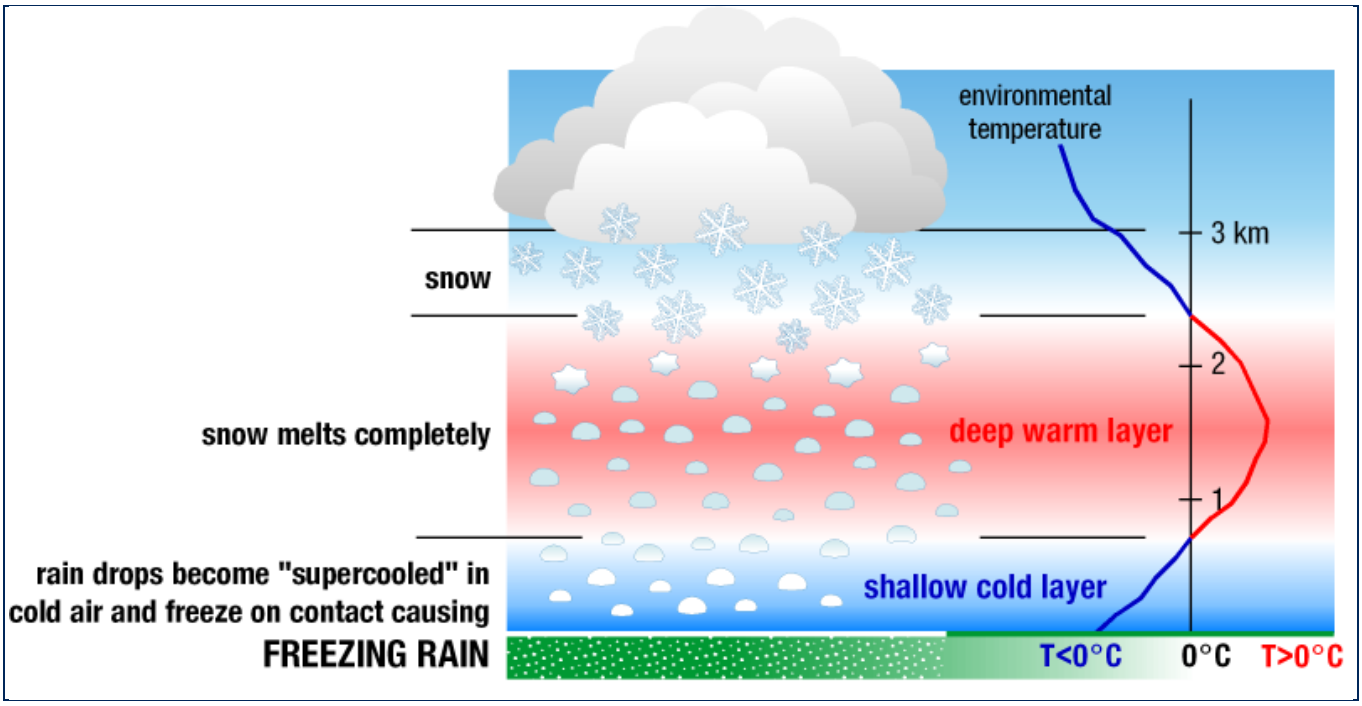
An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations typically are accumulations of 0.25-inches or greater (NOAA n.d.). Heavy accumulations of ice can bring down trees, power lines, utility poles, and communication 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 12-2 depicts freezing rain creation.

Nor'easter

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 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 (NWS n.d.). Nor'easters can span thousands of miles, impacting large areas of coastline. To be classified a nor'easter, a storm must have the following conditions (NJOEM 2024):

- Persists for at least a 12-hour period
- Has a closed circulation
- Shows general movement from the south-southwest to the north-northeast
- Contains wind speeds greater than 23 miles per hour (mph)

Figure 12-2. Freezing Rain Creation



Source: NOAA 2023

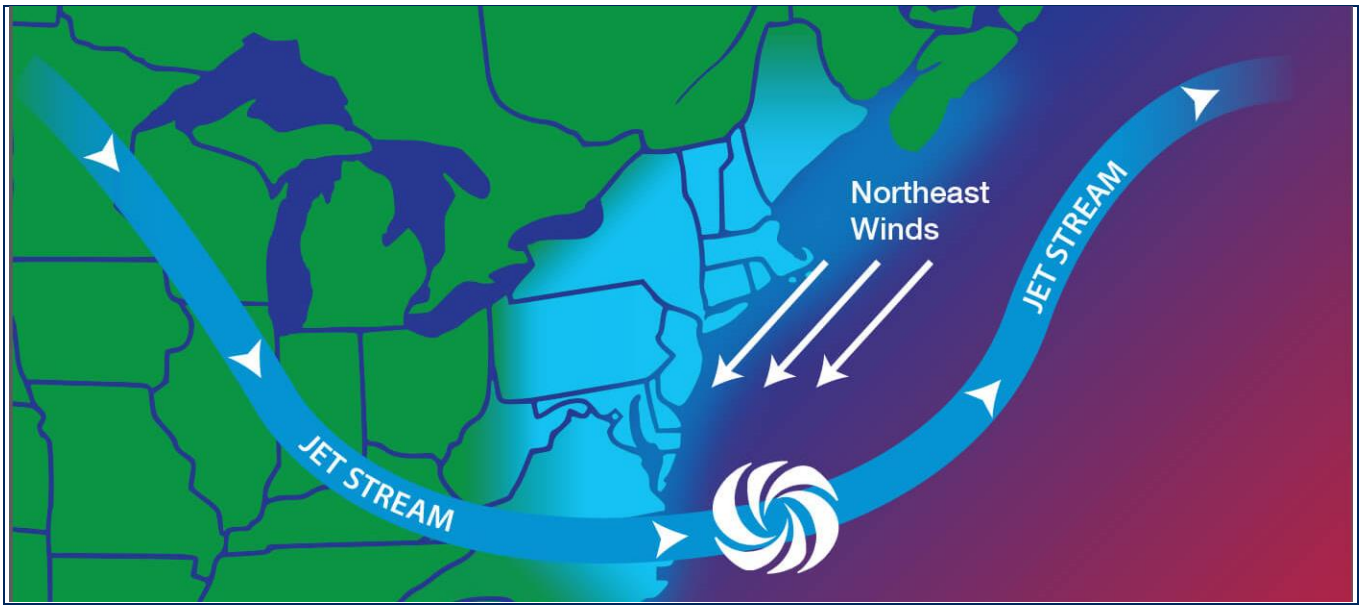
A nor'easter event can cause heavy rain, heavy snow, and wind, with storm surges, waves, and coastal flooding in areas along the coast. With a forward speed much slower than that of a hurricane, a nor'easter can linger for days and cause tremendous damage to affected areas. Approximately 20 to 40 nor'easters occur in the northeastern United States every year (NPS 2023). New Jersey can experience 10 to 20 nor'easters each year, with five to 10 of those having significant impact on the state (NJOEM 2024).

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. Figure 12-3 displays the formation of a Nor'easter.

SLEET

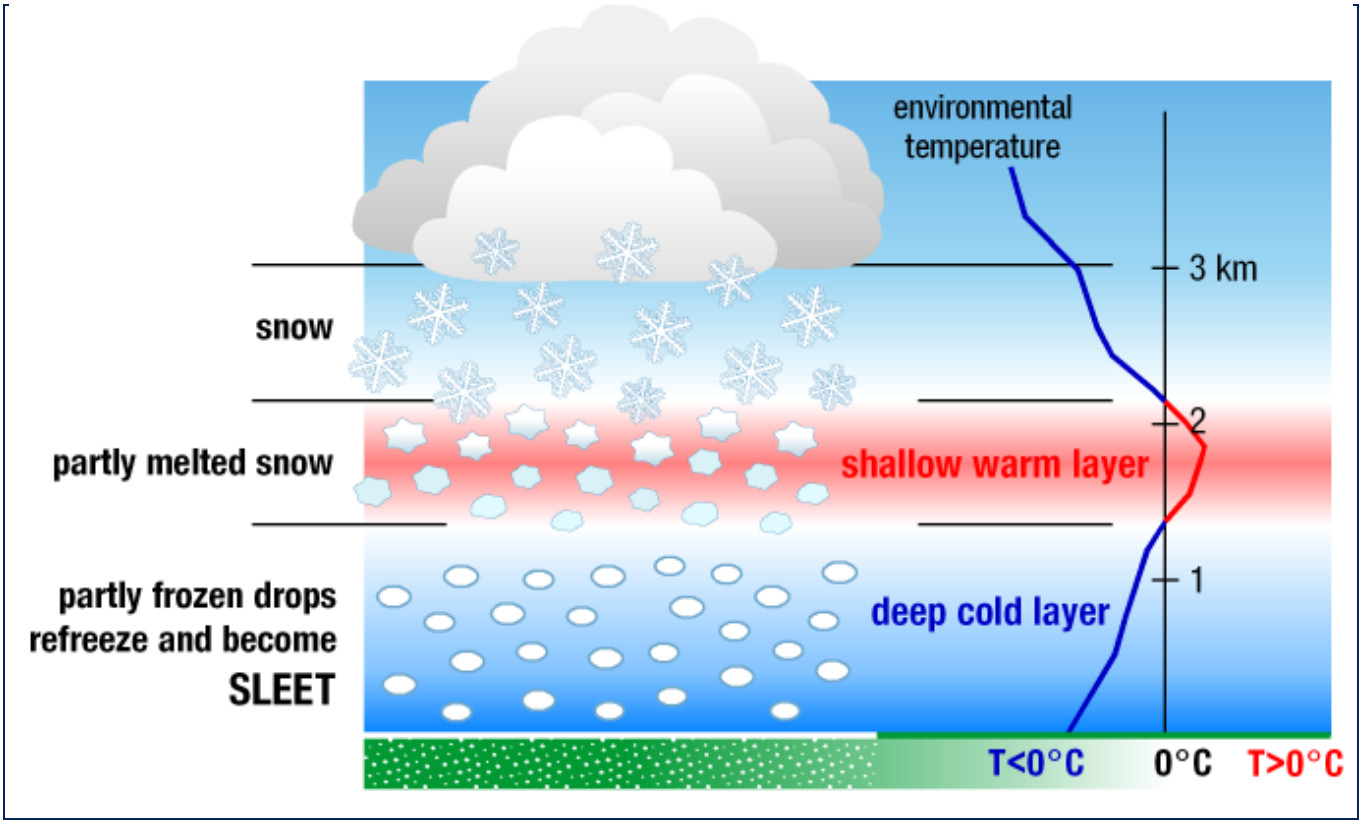
Sleet is made up of drops of rain that freeze into ice as they fall. They are usually smaller than 0.30 inch in diameter (NSIDC 2024). A sleet storm involves significant accumulations of solid pellets, which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists (NSIDC 2024). Figure 12-4 depicts sleet creation.

Figure 12-3. Formation of a Nor'easter



Source: NOAA 2023

Figure 12-4. Sleet Creation



Source: NOAA 2023

12.1.2 Location

Heavy Snow, Blizzards, and Sleet

The severe winter weather hazard has the potential to impact the entire county. However, 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.

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 (NJOEM 2024). 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.

Nor'easter

Historical data shows that several nor'easters have impacted the State. Nor'easters can occur any time of the year but are most frequent and strongest between September and April (NWS n.d.). The entire State of New Jersey is susceptible to the effects of these storms, depending on the storm's track. However, coastal communities and other low-lying areas of the State are particularly vulnerable. As development and re-development increase, even less-intense storms may lead to costly storm damage. Most of the damage following these storms often results from residual wind damage, as was demonstrated during recent storms.

12.1.3 Extent

Heavy Snow, Blizzards, Ice Storms, and Sleet

The magnitude or severity of a severe winter weather 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 weather can be classified both by meteorological measurements and by evaluating societal impacts. The National Oceanic and Atmospheric Administration's (NOAA) 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 12-1 presents the five RSI ranking categories.

Table 12-1. 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 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).

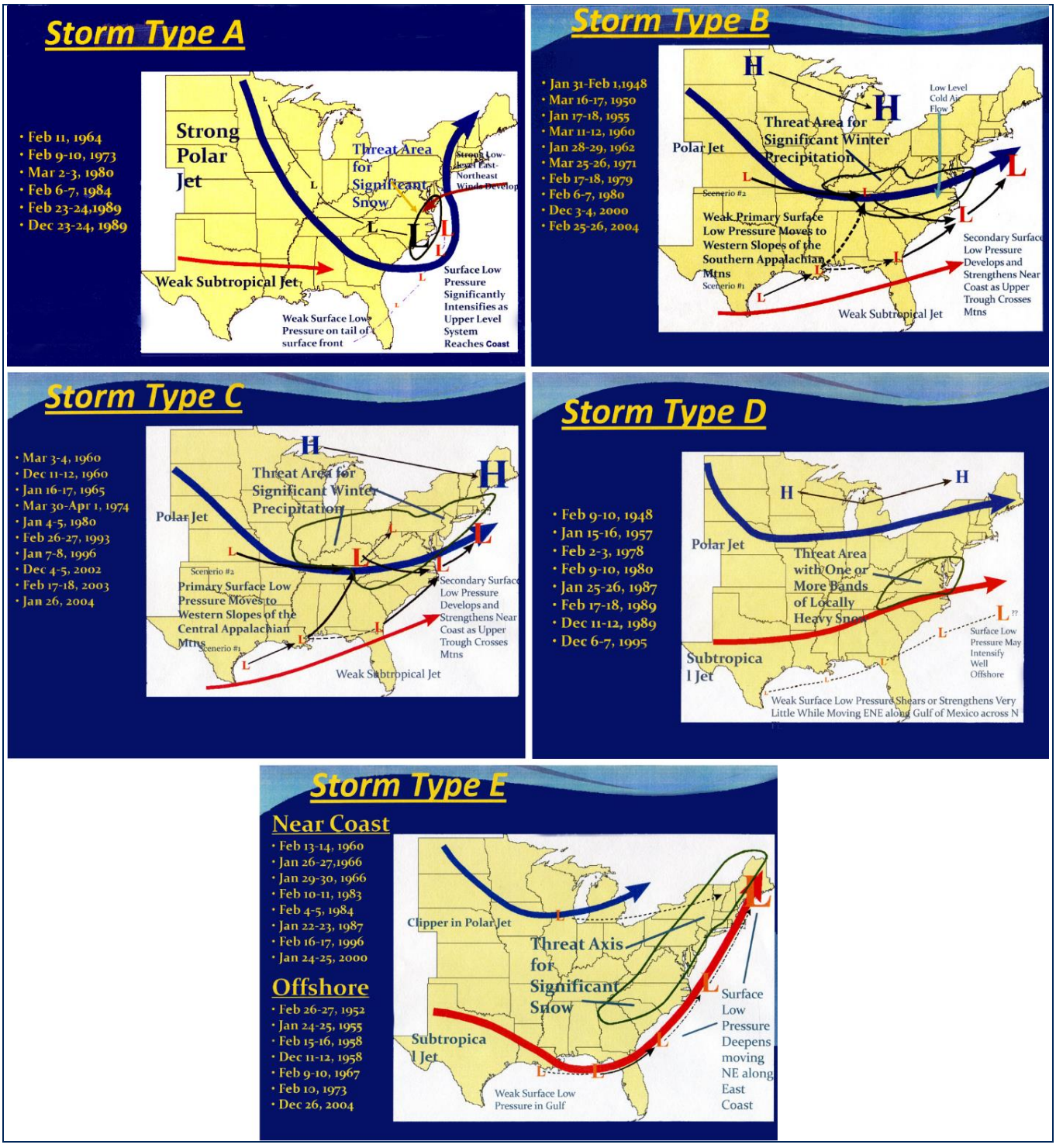
NOR'EASTER

The extent of a nor'easter can be classified by meteorological measurements and by evaluating its societal impacts. Nor'easters have the potential to impact society to a greater extent than hurricanes and tornadoes. These storms often have a diameter three to four times larger than a hurricane and therefore impact much larger areas. More homes and properties become susceptible to damage as the size and strength of a nor'easter intensifies (NWS n.d.). The severity of a 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, time of occurrence during the day (e.g., weekday versus weekend), and season.

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 12-5 for visuals on the formation of each Miller Category.

Figure 12-5. Nor'easter Miller Classifications



Source: Siebers n.d.

12.1.4 Previous Occurrences

FEMA Major Disaster and Emergency Declarations

Between 1954 and 2023, Hudson County was included in five major disaster (DR) or emergency (EM) declarations for severe winter weather-related events (FEMA 2023). Table 12-2 lists these declarations.

Table 12-2. FEMA Declarations for Severe Winter Weather Events in Hudson County (1954 to 2023)

Event Date	Declaration Date	Declaration Number	Description
March 13 to 17, 1993	March 17, 1993	EM-3106	Severe Blizzard
January 7 to 12, 1996	January 13, 1996	DR-1088	Blizzard of '96
February 16 to 17, 2003	March 20, 2003	EM-3181	Heavy Snow
December 26 to 27, 2010	February 4, 2011	EM-1954	Severe Winter Storm and Snowstorm
January 22 to 24, 2016	March 14, 2016	DR-4264	Severe Winter Storm and Snowstorm

Sources: FEMA 2024

USDA 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 contiguous counties. Between 2019 and 2023, Hudson County was not included in any USDA severe winter weather-related agricultural disaster declarations (USDA 2024).

Previous Events

Known hazard events that impacted Hudson County between August 2019 and December 2023 are discussed in Table 12-3. For events prior to 2019, refer to the 2020 Hudson County HMP.

12.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

Information on previous severe winter weather occurrences in the County was used to calculate the probability of future occurrence of such events, as summarized in Table 12-4. Based on historical records and input from the Steering Committee, the probability of occurrence for severe winter weather in the County is considered "occasional."

Table 12-4 does not include the annual probability of nor'easters or freezing rain because these events are not discretely recorded in the National Centers for Environmental Information (NCEI) database. Because of limitations in classifying and tracking of nor'easter events, 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 (NWS n.d.).

Table 12-3. Severe Winter Weather Events in Hudson County (2019 to 2023)

Event Date	FEMA or State Declaration Number	Hudson County included in declaration?	Location Impacted	Description
December 1, 2019	N/A	N/A	County-wide	Snowfall totals amounted roughly 2.5 inches, based on reports in Harrison.
December 16, 2020	N/A	N/A	County-wide	A winter storm developed along the Atlantic Coast, producing about 10 inches of snow based on reports in Kearny and Harrison. Wind gust speeds reached 43 mph at Bayonne and 47 mph at Newark-Liberty Airport.
February 1, 2021	N/A	N/A	County-wide	A winter storm developed over the Ohio Valley and Middle Atlantic, producing about around 17 to 18 inches of snow based on reports in Hoboken and Harrison, respectively. Wind gusts reached 41 mph based on records from Bayonne.
February 7, 2021	N/A	N/A	County-wide	A winter storm developed off the North Carolina and Virginia coast. Moderate to heavy snow fell across the urban corridor in northeast New Jersey during the morning and early afternoon hours. Snowfall accumulation ranged from four to eight inches.
February 18, 2021	N/A	N/A	County-wide	A long winter weather event produced moderate to heavy snowfall and sleet across northeast New Jersey. Precipitation became freezing rain during the late afternoon and overnight. Snowfall accumulation ranged from 4 to 5 inches.
January 6, 2022	N/A	N/A	County-wide	Hudson County received around six inches of snow.
January 28, 2022	N/A	N/A	County-wide	A nor'easter produced wind gusts up to 40 mph across northeastern New Jersey. Snowfall accumulations reached 7 inches in Harrison and 8.5 inches in Hoboken and Jersey City.
February 13, 2022	N/A	N/A	County-wide	A winter weather event produced light snowfall across northeastern New Jersey. The maximum snow accumulation recorded in the County was 2.7 inches in Harrison.
February 27, 2023	N/A	N/A	County-wide	A cold air mass led to widespread snowfall of one to three inches throughout Hudson County.

Sources: NOAA-NCEI 2024

Table 12-4. Probability of Future Severe Winter Weather Events in Hudson County

Hazard Type	Number of Occurrences Between 1996 and 2023	Percent Chance of Occurring in Any Given Year
Heavy Snow	30	100%
Blizzard	3	11%
Ice Storms	0	0%
Winter Storms*	22	79%
Winter Weather	15	54%
Sleet	0	0%
Total		**100%**

Sources: NOAA-NCEI 2024

Notes: Nor'easter events are not tracked in the NCEI database but are often recorded as winter storms

Effect of Climate Change on Future Probability

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. Coastal areas may be impacted by climate change in different ways. Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures.

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Temperatures in the northeastern United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and 2001-2010 (Sustainable Jersey Climate Change Adaptation Task Force 2011). 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 (NOAA 2023). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Fourth National Climate Assessment 2017). 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, the State 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. The State will experience more intense rain events, less snow, and more rainfalls (NJDEP 2020). Most of the additional precipitation is expected to come during the winter months (NOAA 2023).

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 when winter storms do occur, they are more intense and severe than in the past. Some climatologists predict that climate change may play a role in the frequency and intensity of nor'easters. Two ingredients are needed to produce strong nor'easters and intense snowfall: (1) temperatures which are just below freezing, and (2) massive moisture coming from the Gulf of Mexico. When temperatures are far below freezing, snow is less likely. As temperatures increase in the winter months, they will be closer to freezing rather than frigidly cold. Future climate change has been predicted to produce more moisture, thus increasing the likelihood that these two ingredients (temperatures just below freezing and intense moisture) will cause more intense snow events. However, 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 Hudson County.

12.1.6 Cascading Impacts on Other Hazards

Severe winter weather may exacerbate flooding. As discussed, the heavy precipitation and freezing and thawing of snow and ice can create major flooding issues in the County. Nor'easter events can also create coastal flooding which can impact the southeastern portion of the County. Refer to Chapter 9 (Flood) for more information about the flood hazard of concern.

Severe winter weather events, especially nor'easters, often coincide with or are followed by extreme cold events and generate strong winds that create very low wind chills. For more information on the extreme cold hazard, refer to Chapter 8 (Extreme Temperature).

High winds and ice and snow accumulation can be destructive to the functionality of utilities by breaching power lines and disconnecting the utility systems. Severe winter weather could also result in falling trees and branches due to ice, snow, and strong winds. Fallen trees and branches increases available fuel for wildfires. For more information on the wildfire hazard, refer to Chapter 13 (Wildfire).

12.2 Vulnerability and Impact Assessment

All of Hudson County is vulnerable to severe winter weather events. The following subsections discuss Hudson County's vulnerability, in a qualitative nature, to the severe winter weather hazard.

12.2.1 Life, Health, and Safety

Overall Population

The entire population of Hudson County (724,854) is exposed to severe winter weather events (US Census Bureau 2020). Likely impacts of this hazard include the following:

- Snow accumulation and frozen or slippery road surfaces increase the frequency and impact of traffic accidents for the general population, resulting in personal injuries or deaths.
- Winter weather indirectly and deceptively kills hundreds of people in the U.S. each year, primarily due to automobile accidents, overexertion, and exposure.
- These events are often accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, drifting snow, extreme cold temperatures, and dangerous wind chills.
- People can suffer heart attacks while shoveling snow or succumb to 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.

SOCIALLY VULNERABLE POPULATION

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.

Without a quantitative assessment of potential impacts of a drought on socially vulnerable populations, the Planning Partners can best assess mitigation options through an understanding of the general numbers and locations of such populations across Hudson County. Section 3.6.4 provides detailed data on socially vulnerable populations within the planning area. Table 12-5 summarizes highlights of this information. For planning purposes, it is reasonable to assume that percentages and distribution of socially vulnerable populations affected by a drought will be similar to the countywide numbers.

Table 12-5. Distribution of Socially Vulnerable Populations by Municipality

	Countywide Total		Municipality Highest in Category		Municipality Lowest in Category	
Category	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Population Over 65	**86,664**	**12.0%**	Jersey City 32,671	North Bergen **16.6%**	East Newark **308**	Hoboken **6.4%**
Population Under 5	**86,664**	**12.0%**	Jersey City 20,476	Bayonne **7.1%**	East Newark **106**	East Newark **4.1%**
Non-English-Speaking Population	**93,494**	**12.9%**	Jersey City 29,070	West New York **24.5%**	East Newark **474**	Hoboken **4.3%**
Population With Disability	**61,174**	**8.4%**	Jersey City 22,396	Union City **11.2%**	East Newark **209**	Weehawken **6.2%**
Population Below Poverty Level	**99,546**	**13.7%**	Jersey City 43,134	East Newark **24.6**	East Newark **638**	Seacaucus **5.1%**
Households Below ALICE Threshold	**63,893**	**21%**	Jersey City **119,278**	Union City **49%**	East Newark **846**	Hoboken **20%**

12.2.2 General Building Stock

The entire general building stock inventory is exposed and vulnerable to the severe winter weather hazard and could be more at risk from aging infrastructure. An extreme blizzard or snowstorm event can carry and deposit significant amounts of snow that are heavy enough to damage roofs and aging buildings. In general, the structural impacts include partial damages to roofs and building frames, rather than an entire building.

Table 12-6 provides estimates of potential damage costs from severe winter weather for various jurisdictions within Hudson County. It includes the number of buildings in each jurisdiction and the estimated losses at different assumed damage levels (1, 5, and 10 percent).

Table 12-6. Estimated Potential Damage Costs from Severe Winter Weather in Hudson County

Jurisdiction	Number of Buildings Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Bayonne (C)	9,264	$112,789,650	$563,948,248	$1,127,896,496
East Newark (B)	434	$3,007,123	$15,035,615	$30,071,230
Guttenberg (T)	2,574	$10,627,725	$53,138,625	$106,277,251
Harrison (T)	2,646	$28,122,699	$140,613,496	$281,226,992
Hoboken (C)	14,289	$69,228,497	$346,142,483	$692,284,965
Jersey City (C)	38,336	$298,292,768	$1,491,463,839	$2,982,927,678
Kearny (T)	7,207	$96,306,266	$481,531,328	$963,062,657
North Bergen (T)	6,002	$99,067,063	$495,335,316	$990,670,633
Secaucus (T)	3,844	$120,750,885	$603,754,427	$1,207,508,855
Union City (C)	1,729	$40,097,124	$200,485,621	$400,971,243
Weehawken (T)	2,112	$16,381,121	$81,905,605	$163,811,211
West New York (T)	4,594	$30,768,563	$153,842,817	$307,685,634
Hudson County (Total)	**93,031**	**$925,439,484**	**$4,627,197,422**	**$9,254,394,844**

Source: NJOIT, Office of GIS 2024; Microsoft BING 2019, RS Means 2024

12.2.3 Community Lifelines and Other Critical Facilities

Full functionality of critical facilities such as police, fire, and medical facilities is essential for response during and after a severe winter weather event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from severe winter weather 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 of winter weather related damages including cracks and potholes caused by freezing plowing are required (NWS 2019).

Heavy accumulations of snow and 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. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NWS 2019). Heavy snow can immobilize a region and paralyze a city, shutting down all air and rail transportation and disrupting medical and emergency services (NOAA 2023).

12.2.4 Economy

The cost of snow and ice removal, roadway treatments (salt and brine) and repair of roads from the freeze/thaw process and plowing damages can drain local financial resources. In addition to snow removal costs, severe winter weather affects the ability of persons to commute into and 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 and may cause a loss in

economic productivity. The economic impact of winter weather each year is huge, with costs for snow removal, damage, and loss of business in the millions (NOAA 2023).

According to FEMA's National Risk Index, Hudson County's expected annual losses from severe winter weather events are as follows (FEMA 2024):

- Ice Storm: $213,000
- Winter Weather: $244,000

12.2.5 Natural, Historic and Cultural Resources

NATURAL

Severe winter weather can have a major 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. 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. (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).

HISTORIC

Historic buildings may be susceptible to damage from severe winter weather conditions. Proper strategies help safeguard buildings and their contents. Sudden and dramatic fluctuations in heating or cooling should be minimized. Slower heating and cooling give building materials and stored contents time to acclimate to new temperatures in the building and corresponding new humidity levels (CCAHA 2019).

Historic buildings, archaeological sites, and artifacts are vulnerable to severe winter weather due to several factors. Freeze-thaw cycles can cause significant damage as water seeps into cracks, freezes, expands, and then thaws, leading to the gradual breakdown of materials like stone, brick, and mortar. Snow and ice introduce moisture into structures and artifacts, which can freeze and cause expansion and cracking, while fluctuating humidity levels can deteriorate organic materials like wood and textiles.

CULTURAL

Cultural heritage sites, particularly those exposed to the elements, are subject to weathering. The weight of accumulated snow and ice can stress roofs and other structural elements, potentially leading to collapses. Extreme cold makes materials more brittle and susceptible to cracking, and sudden temperature changes can cause thermal shock, damaging delicate artifacts. Additionally, severe winter weather can hinder access and maintenance, making it challenging to perform necessary upkeep and repairs (NPS 2016).

12.3 Future Changes That May Affect Risk

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

12.3.1 Potential or Planned Development

Areas targeted for future growth and development have been identified across the County. As development and re-development increase, even less-intense storms may lead to costly storm damage. Potential or planned development can influence the risk and impact of severe winter weather in several ways. As development expands into previously undeveloped areas, more people and properties become exposed to the risks of severe winter weather, leading to higher potential for economic losses and disruptions.

Urbanization often leads to the creation of urban heat islands, which are warmer than their rural surroundings due to human activities and infrastructure. While this might reduce the severity of winter weather in urban areas, it can also lead to more significant temperature contrasts and potentially more intense weather events.

New developments might not always be designed with severe winter weather in mind, especially in regions that historically experience milder winters, increasing the vulnerability of buildings, roads, and utilities to damage from snow, ice, and freezing temperatures. Rapid development can also strain local resources and emergency services, making it more challenging to respond effectively to severe winter weather events

Additionally, development can alter natural landscapes, affecting local weather patterns and potentially increasing the frequency or severity of winter weather events. For example, deforestation and changes in land cover can influence local climate conditions.

12.3.2 Projected Changes in Population

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, Hudson County is projected to have an increase in population in the upcoming years. These projection totals include a population of 747,400 by 2029, and 766,500 by 2034 (State of New Jersey 2017). An increase in population density can significantly hinder the ability of residents in the County to mobilize or receive essential services during severe winter weather events, as higher demand for resources and services can overwhelm infrastructure and emergency response systems. Refer to Chapter 3 (County Profile), which includes a more thorough discussion about population trends for the County.

12.3.3 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 as winter weather. While predicting changes of severe winter weather 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).

12.3.4 Other Identified Conditions

New Jersey will see an increase in average annual temperatures and precipitation. Climate change has the ability to make winter weather events less frequent, but more severe when they do happen. Annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to freeze into heavy snowfall and icing. This increase in snow and ice could result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by severe winter events due to loss of service or access (The Climate Reality Project 2022).