4.3.12 Severe Winter Weather

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

2020 HMP Changes

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

4.3.12.1 Profile

Hazard Description

Severe winter weather is considered when a storm brings 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 Morris County, winter storms include blizzards, snow storms, Nor'Easters and ice storms. Extreme cold temperatures and wind chills are also associated with winter storms which is discussed further in Section 4.3.5 (Extreme Temperature).

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 2008).

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 2008).

Freezing Rain

Freezing rain occurs when rain falls into areas that are below freezing. 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 2008).

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 (NWS 2013).

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 can occur any time of the year but are most frequent and strongest between September and April bringing winter weather and can cause flooding. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and typically move from southwest to northeast along the Atlantic Coast of the United States (NOAA 2013b). Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted. In order to be called a Nor'Easter, a storm must have the following conditions, as per the Northeast Regional Climate Center (NRCC):

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

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, Morris County's normal seasonal snowfall is approximately 25-35 inches with the lowest snowfall in the southeast and the highest amount in the northwest.

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.

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-NCEI 2019). Table 4.3.12-1 summarizes the five RSI ranking categories.

Table 4.3.12-1. RSI Ranking Categories

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

Source: NOAA-NCDC 2018

Note: RSI = Regional Snowfall Index

The 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 Morris 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.).

The 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 meets or exceed locally/regionally defined 12 and/or 24-hour warning criteria.
- Ice storm is reported in the NOAA-NCEI database when ice accretion meets 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 ½ 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.

Previous Occurrences and Losses

Between 1954 and March 15, 2019, the Federal Emergency Management Agency (FEMA) included Morris 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 4.3.12-2. 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

Declaration	Event Date	Declaration Date	Event Description
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

Table 4.3.12-4 summarizes winter storm events and FEMA disaster declarations that occurred between 2014 and 2019.

According to the Storm Events Database, Morris County has been impacted by 262 severe winter storm events between 1950 and January 2019 (Table 4.3.12-3). No events resulted in deaths, injuries, or crop damages. Events resulted in $3.575 million in property damages.

Table 4.3.12-3. Severe Winter Storm Events in Morris County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Blizzard	3	0	0	$1.5M	$0
Heavy Snow	39	0	0	$2.0M	$0
Ice Storm	3	0	0	$0	$0
Sleet	5	0	0	$0	$0
Winter Storm	57	0	0	$75K	$0
Winter Weather	155	0	0	$0	$0
Total	**262**	**0**	**0**	**$3.575M**	**$0**

Note: Not all events that have occurred in Morris County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
K: Thousand
M: Million
Source: NOAA-NCEI 2019

Table 4.3.12-4. Severe Winter Weather Events in Morris County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Morris County Designated?	Location	Description
January 2, 2014	Heavy Snow	N/A	N/A	Morris County	A winter storm dropped 5 to 9 inches of snow across most of New Jersey. This caused hazardous traveling conditions for the evening commute on the 2nd and the morning commute on the 3rd. Governor Chris Christie declared a state of emergency in New Jersey. New Jersey State Police reported about 250 storm related accidents and 900 calls from stranded motorists. In addition, AAA Mid-Atlantic responded to an additional 200 calls for assistance from stuck motorists in Pennsylvania and New Jersey. After one day of classes after the winter break, many schools were closed again on the 3rd.
January 21, 2014	Heavy Snow	N/A	N/A	Morris County	A winter storm dropped heavy snow across New Jersey and along the Interstate 95 corridor northeast through Monmouth County from the morning of the 21st into the early morning on the 22nd. Snowfall totals in this corridor averaged 10 to 16 inches with lower amounts in the northwest and southeast parts of the state. The heavy snow resulted in New Jersey Governor Chris Christie in declaring a state of emergency as state offices were closed early on the 21st. Many schools, courts, government offices, businesses and malls closed early on the 21st and this led to long traffic delays because of the coincidental early releases. Snow removal crews found it difficult to plow on congested roadways. New Jersey State Police reported over 400 accidents and assisted over 800 stranded drivers. One of the worst accidents occurred in Roxbury Township (Morris County) on eastbound Interstate 80 when a charter bus slid down an embankment and struck a tree. Four people were injured.
February 3, 2014	Heavy Snow	N/A	N/A	Morris County	Snow fell across the central and northern third of New Jersey mainly from the early morning through the late afternoon on the 3rd. In central New Jersey, precipitation started as rain at the onset which changed over quickly to snow. The southern third of the state remained mostly rain with little to no snow accumulation. Snowfall varied greatly across the area but in general a widespread 6 to 9 inches of snow was recorded in the northern half of the state, with progressively lesser amounts farther south in the southern half of the state. The heaviest snow fell during the daylight hours during the morning and ended between 4 p.m. EST and 6 p.m. EST that evening. A State of Emergency was declared by Governor Chris Christie due to the impacts of the snow across the state. Non-essential state employees were dismissed early. Businesses and local governments staggered dismissals. The snow caused slippery traveling conditions, especially on untreated and less traveled roadways. Many municipalities declared snow emergencies. Many schools were closed and other events were postponed or cancelled. The heavy snow caused suspension of trash and recycling collections and caused salt supplies to run low. More salt was already used through this storm than all of last winter season.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Morris County Designated?	Location	Description
February 5, 2014	Winter Storm	N/A	N/A	Morris County	A major winter storm brought heavy snow and sleet to northwest New Jersey and a wintry mix which included a significant accumulation of ice to the central third of New Jersey. The snow that was still on the trees from the just concluded winter storm was a major contributing factor to the power outages. The weight of the snow, then sleet and freezing rain on limbs all collaborated to cause more tree damage then would have occurred if trees were bare at the start of the event. It was the worst ice related outages in the Public Service Electric and Gas's service area since 1999. Governor Chris Christie declared a State of Emergency and all New Jersey State offices were closed on the 5th for all non-essential workers. Except in the southeast part of the state, schools were closed. New Jersey State Police responded statewide to about 170 accidents and around 180 calls for assistance from disabled motorists.
February 13, 2014	Winter Storm	N/A	N/A	Morris County	A winter storm dropped heavy snow and sleet as well as some freezing rain across most of New Jersey, except for the immediate coast. Snowfall and sleet totals average 10 to 20 inches from around the Interstate 95 corridor northwestward with the highest amounts in Warren and Sussex Counties. Elsewhere, snowfall and sleet amounts dropped considerably the closer to the coast municipalities were located. Ice accumulations were generally less than one tenth of an inch. Three bands of heavy snow, in which snowfall rates averaged two to three inches per hour, moved through the state. The first one mainly affected the southern third of the state around 3 a.m. EST on the 13th. The second one moved through the entire southern half of the state (away from the coast where it was rain by then) between 4 a.m. EST and 7 a.m. EST on the 13th. The last one formed in the southern half of the state around 6 a.m. EST on the 13th and proceeded to move north through the entire state by 2 p.m. EST on the 13th. After the snow bands moved through, precipitation changed to rain in the southeast part of the state during the morning of the 13th, the southwest and central part of the state during the second half of the morning and around midday on the 13th and during the afternoon of the 13th in the northwest part of the state. Some pockets of freezing persisted. Thunderstorms moved through the state during the late afternoon and early evening on the 13th, some with small hail. Then as the low-pressure system pulled offshore, precipitation changed back to snow during the second half of the evening on the 13th and ended after Midnight EST on the 14th. The last snow band exited New Jersey between 2 a.m. EST and 5 a.m. EST on the 14th. Governor Chris Christie declared a state of emergency and New Jersey State Offices were closed and non-essential personnel did not have to report to work. Many schools, malls, businesses, other government and local offices as well as municipal courts never opened on the 13th. Many schools in the northern part of the state were also closed on the 14th. New Jersey State offices opened late on the 14th.
November 26, 2014	Winter Storm	N/A	N/A	Morris County	A winter storm on the 26th, the day before Thanksgiving Day, dropped heavy snow over parts of northwest New Jersey and caused power outages as well as additional traveling difficulties. Governor Chris Christie declared a state of emergency. Speed limits were reduced on all major roadways. Snowfall along the Interstate 95/295 corridor averaged around an inch, but snowfall reached between 3 and 12 inches in the northwest part of the state and was very elevation dependent. The weight of the heavy, wet snow tore down tree limbs, trees and power lines in the northwest part of the state. About 23,000 homes

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Morris County Designated?	Location	Description
					and businesses lost power. Many schools in the northern part of the state either closed or dismissed students early.
January 24, 2015	Heavy Snow	N/A	N/A	Morris County	A winter storm dropped heavy snow in Northwest New Jersey and a mixture of snow, sleet and freezing rain in the central and southwest part of New Jersey on the evening of the 23rd into the morning of the 24th. Overall less wintry precipitation (a faster switch to rain) occurred progressively farther to the south and southeast in the state. Snowfall averaged 5 to 9 inches in northwest New Jersey; 2 to 5 inches in central New Jersey and less than two inches across southwest New Jersey. No snow fell in southeast New Jersey. Ice accumulations were generally around a trace. The snow caused traveling difficulties as well as postponement of social activities on the 24th. There were over 100 reported accidents in the state. The snow and accidents caused about 2,000 homes and businesses to lose power. New Jersey Transit cross-honored all commuting tickets. The onshore flow from the winter storm also caused minor tidal flooding in southern New Jersey during the morning high tide cycle on the 24th. Precipitation started as snow on the evening of the 23rd from southwest New Jersey northward between 9 p.m. EST and Midnight EST. In Northwest New Jersey, the snow fell at its heaviest during the pre-dawn hours on the 24th and ended between 8 a.m. EST and 10 a.m. EST on the 24th. In the Raritan Valley, snow also fell at its heaviest during the pre-dawn hours on the 24th, but then changed to freezing rain and sleet between 4 a.m. EST and 6 a.m. EST on the 24th. Precipitation in some areas changed to plain rain before ending later that morning. In the central third of New Jersey, a change to rain (with some sleet at the transition time) worked its way to the northwest from coastal areas and occurred between 1 a.m. EST and 5 a.m. EST on the 24th and remained rain until it ended around 8 a.m. EST on the 24th. Eight inches of snow fell in Marcella, 6.9 inches in Rockaway, 6.5 inches in Parsippany.
February 1, 2015	Winter Storm	N/A	N/A	Morris County	A winter storm brought a heavy mixture of snow, some sleet and freezing rain to the Raritan Valley and northwest New Jersey with less of a wintry impact to the rest of central and southwest New Jersey on the first into the second. The storm greatly impacted the morning commute on the 2nd in the northwest part of the state. Precipitation started as snow throughout the northern half and southwest part of New Jersey during the evening of the 1st. In northwest New Jersey including the Passaic Basin, the snow transitioned to a sleet and/or freezing rain mixture during the morning of the 2nd, then changed back to snow by early afternoon and ended during the middle of the afternoon on the 2nd. Speed restrictions were in place on most major roadways in central and northern New Jersey on the 2nd. Many schools in central New Jersey had delayed openings on the 2nd. 8 inches of snow fell in Marcella, 6 inches in Boonton. Ice accumulations reached as high as one to two tenths of an inch in the Raritan Valley and averaged less than one tenth of an inch in the Passaic Basin.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Morris County Designated?	Location	Description
March 5, 2015	Heavy Snow	N/A	N/A	Morris County	Waves of low pressure that formed along a sinking cold front brought New Jersey heavy snow and the southern half of the state its heaviest snow of the season. Snowfall averaged 4 to 9 inches with the highest amounts in central New Jersey. The heavy snow prompted Governor Chris Christie to declare a state of emergency and close state offices to non-emergency personnel. Nearly all schools and universities in the state were closed on the 5th. Many were also closed the next day. The snow also caused hazardous travel and hundreds of accidents. New Jersey Transit cross-honored transit tickets on the 5th and 6th. Precipitation with this event started as rain on the 4th. As colder air moved in from the north and precipitation intensity increased, the rain changed to all snow. The snow fell heavy at times in the central and southern part of the state from the late morning into the midafternoon on the 5th. Accidents that closed major roadways included U.S. Route 46 in both directions in Denville. New Jersey State police responded to over 150 accidents and incidents. Amtrak modified its schedule along the Northeast Corridor. PATCO implemented a snow schedule on its commuter rail line. Many bus routes had delays and re-routes. The winter storm caused 3,646 flights (at least 650 in Philadelphia alone) to be canceled. The impact from the winter storm continued into the 6th. Many schools were closed. The PARCC school tests had to be rescheduled. Representative snowfall included 7.4 inches in Randolph Township.
January 22-24, 2016	Blizzard	Yes	DR-4264	Morris County	An impulse from the west coast traversed the midsection of the country, then developed into a low-pressure system as it tracked across the Gulf states before intensifying along the Carolina coast into a major nor'easter, producing record snowfall in parts of New Jersey on January 23rd. It then moved out to sea after passing by the mid-Atlantic coast early on January 24th. Wind gusts up to 60 MPH produced blizzard conditions as visibilities dropped to one-quarter mile or less in spots. Snow began during the evening hours on the 22nd, then continued, heavy at times through the 23rd before ending early on the 24th. Snowfall totals included 30.0 inches in Long Valley, 29.0 inches in Madison, 26.0 inches in Budd Lake, 25.3 inches in Green Pond, 22.5 inches in Butler, 21.0 inches in Chatham, and 18.0 inches in Marcella. At one point during the storm, up to 270,000 customers were without power. On March 15, 2016, President Obama declared the following counties federal disaster areas: Atlantic, Burlington, Camden, Cape May, Cumberland, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Somerset, and Warren, in addition to Bergen, Essex, Hudson, and Union counties. This declaration makes federal funding available on a cost-sharing basis for hazard mitigation and snow assistance for a continuous 48-hour period during the storm. New Jersey Governor Chris Christie declared a State of Emergency on Friday, January 22nd for the duration of the event. Schools and many businesses recessed early on Friday afternoon in anticipation of the storm.
February 9, 2017	Winter Storm	N/A	N/A	Morris County	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. Wind, coastal flooding, heavy rain and snow all occurred. Heavy rainfall in Southeast New Jersey ranged from 1-3 inches.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Morris County Designated?	Location	Description
March 14, 2017	Blizzard	N/A	N/A	Morris County	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. Wind, coastal flooding, heavy rain and snow all occurred. Snowfall was over a foot across the county.
February 17, 2018	Winter Storm	N/A	N/A	Morris County	Snow began during the late afternoon hours on Saturday, February 16th, then ended during the very early morning hours on Sunday, February 17th. Given the bulk of this snow fell on a Saturday evening, and the fact that antecedent ground temperatures were above freezing, societal impact from this event was minimal. Some representative snowfall totals include: 9.5 inches in Schooleys Mountain, 9.0 inches in Rockaway, 8.5 inches in Parsippany, 8.0 inches in Marcella, 7.5 inches in Lake Hopatcong, and 6.5 inches near New Providence.
March 2, 2018	Winter Storm	N/A	N/A	Morris County	A heavy, wet snow accumulated to a depth of over 11 inches in the higher elevations of the county, and around 2 inches or so in the lower elevations. Some snowfall totals include 11.8 inches in Green Pond, 10.6 inches in Jefferson Township, 10.0 inches in Lake Hopatcong, 9 inches in Mount Arlington, 9.0 inches in Schooleys Mountain, 8.0 inches in Marcella, 6.0 inches in Rockaway, and 4. 3 inches in Denville. A wind gust of 49 MPH was reported in Morristown at 1145EST on March 2nd. Blowing and drifting snow made travel hazardous Friday afternoon and evening. Numerous power outages, some lasting over two weeks, were widespread throughout the county due to tree and wire damage.
March 7, 2018	Winter Storm	DR-4368	Yes	Morris County	Precipitation gradually overspread the region during the overnight hours of March 6th to the 7th. 12 to 24 inches was observed across large parts of Somerset, Hunterdon, Morris, and Sussex Counties. The snow contained large amounts of liquid, making it heavy and wet. This resulted in downed trees, limbs, and wires, leading to numerous power outages across portions of New Jersey, especially where the heaviest snow was reported. Many customers were still without power from the previous storm when this storm struck. Governor Murphy estimated about 350,000 customers state-wide lost power as a result of this second storm. Governor Phil Murphy declared a state of emergency which went into effect at 8 PM Tuesday March 6th. Flights were cancelled at all the major airports due to the storm, and Amtrak cancelled at least some Wednesday service.
March 21, 2018	Winter Storm	N/A	N/A	Morris County	Precipitation began as a wet, heavy snow during the evening hours on March 20th. After a lull during the overnight hours, a drier snow began falling, heavy at times, during the afternoon and evening hours on March 21st. Snowfall totals were lower in the eastern portions of the county were mixing took place. Some snowfall reports include: 12.0 inches in Netcong, Green Pond, and Mine Hill Township, 11.2 inches in Jefferson Township, 11.0 inches in Marcella, 10.5 inches in both Rockaway and Mine Hill Township, 10.0 inches in Succasunna, 9.5 inches in Butler, 9.3 inches in Denville, 9.2 inches in both Budd Lake and Washington Township, 8.8 inches in both Mount Arlington and Randolph Township, 8.4 inches in Morristown, 8.2 inches at Charlottesburg Reservoir, 8.0 inches in Dover, 7.5 inches in Parsippany, 7.0 inches at Boonton Reservoir, 7.0 inches in Millington, 6.5 inches in Pine Brook, 4.0 inches in Beach Glen, and 3.7 inches in Pleasantville.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Morris County Designated?	Location	Description
April 2, 2018	Winter Storm	N/A	N/A	Morris County	Despite high temperatures in the 50's and 60's across the region on April 1st, a cold front moving though the area during the morning gradually brought in colder air, which moved into the region by April 2nd. Meanwhile, a weak wave of low pressure developed along this front and tracked south of the area. To the north of this low and where temperatures were cold enough, snow accumulated, especially near the Interstate 195 corridor and points north. The snow began after midnight on April 2nd and continued into the mid-morning hours. A trained spotter reported 7.3 inches of snow in Green Pond.
November 15, 2018	Winter Storm	N/A	N/A	Morris County	An early season winter storm resulted in snow totals ranging from 7.9 inches in Morristown to 6 inches in Roxbury Township.
February 12, 2019	Winter Storm	N/A	N/A	Morris County	This event was the second part of a multi-day storm that impacted the region with light snow changing to a wintry mix and then to rain. Trained spotters reported 3.0 of snow in Green Pond and 0.20 of ice in Denville.
March 3, 2019	Winter Storm	N/A	N/A	Morris County	An offshore low-pressure system brought a period of heavy precipitation to the mid-Atlantic. A mix of rain, sleet, and snow was observed, with snow confined mainly to interior areas and sleet and rain more abundant near the coast. A trained spotter in Green Pond reported 9.1 inches of snow, with widespread 7 to 9-inch totals across the County.

Source: NOAA-NCEI 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

Probability of Future Occurrences

Morris County is estimated to continue experiencing direct and indirect impacts of severe winter storms annually. Table 4.3.12-5 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 4.3.12-5. Severe Winter Storm Events in Morris 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	Percent (%) Chance of Event Occurring in Any Given Year
Blizzard	3	0.04	23.33	0.04	4.3
Heavy Snow	39	0.57	1.79	0.56	55.7
Ice Storm	3	0.04	23.33	0.04	4.3
Sleet	5	0.07	14.00	0.07	7.1
Winter Storm	57	0.83	1.23	0.81	81.4
Winter Weather	155	2.5	0.45	2.21	221.4
Total	**262**	**3.80**	**0.27**	**3.7**	**374.3**

Note: Not all events that have occurred in Morris 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 Morris 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 weather 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 2011).

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2017). 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. 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 Morris County is exposed to the severe winter weather hazard. The following discusses Morris County's vulnerability, in a qualitative nature, to the severe winter weather hazard.

Impact on Life, Health, and Safety

The entire population of Morris County is exposed to severe winter weather events (population of 498,847 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, 15.8% of the population in Morris County is over 65 years in age. Severe winter storm events can reduce the ability of these populations to access emergency services. Furthermore, 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 Morris County, 4.7% of the population has annual incomes below the Census-defined poverty level. Victory Gardens Borough has the greatest percent of persons in poverty to its total population (24.6%).

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 Morris County are exposed to the severe winter weather hazard; however, properties in poor condition may be more vulnerable to impacts. Table 4.3.12-3 shows that there have been approximately $3.5 million worth of property damages because of a severe winter weather event. 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 4.3.12-6 summarizes the estimated impact to structures by calculating 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 4.3.12-6. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Municipality	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Town of Boonton	$1,832,625,537	$18,326,255	$91,631,277	$183,262,554
Township of Boonton	$1,388,780,135	$13,887,801	$69,439,007	$138,878,014
Borough of Butler	$1,489,686,071	$14,896,861	$74,484,304	$148,968,607
Chatham Borough	$1,673,960,469	$16,739,605	$83,698,023	$167,396,047
Chatham Township	$2,300,237,613	$23,002,376	$115,011,881	$230,023,761
Chester Borough	$694,668,411	$6,946,684	$34,733,421	$69,466,841
Chester Township	$2,782,631,274	$27,826,313	$139,131,564	$278,263,127
Denville Township	$4,397,845,504	$43,978,455	$219,892,275	$439,784,550
Town of Dover	$2,640,787,978	$26,407,880	$132,039,399	$264,078,798
Township of East Hanover	$4,740,072,304	$47,400,723	$237,003,615	$474,007,230
Borough of Florham Park	$3,768,421,982	$37,684,220	$188,421,099	$376,842,198
Township of Hanover	$5,609,469,027	$56,094,690	$280,473,451	$560,946,903
Township of Harding	$1,808,255,972	$18,082,560	$90,412,799	$180,825,597
Township of Jefferson	$4,421,074,958	$44,210,750	$221,053,748	$442,107,496
Borough of Kinnelon	$2,858,766,250	$28,587,663	$142,938,313	$285,876,625
Borough of Lincoln Park	$2,125,371,898	$21,253,719	$106,268,595	$212,537,190
Township of Long Hill	$2,253,461,094	$22,534,611	$112,673,055	$225,346,109
Borough of Madison	$3,066,320,935	$30,663,209	$153,316,047	$306,632,094
Borough of Mendham	$1,479,178,043	$14,791,780	$73,958,902	$147,917,804
Township of Mendham	$2,099,041,883	$20,990,419	$104,952,094	$209,904,188
Township of Mine Hill	$766,971,485	$7,669,715	$38,348,574	$76,697,149
Township of Montville	$6,714,034,036	$67,140,340	$335,701,702	$671,403,404
Township of Morris	$6,091,077,654	$60,910,777	$304,553,883	$609,107,765
Borough of Morris Plains	$1,738,775,034	$17,387,750	$86,938,752	$173,877,503
Town of Morristown	$2,945,511,672	$29,455,117	$147,275,584	$294,551,167
Borough of Mount Arlington	$1,065,424,961	$10,654,250	$53,271,248	$106,542,496
Township of Mount Olive	$7,181,400,421	$71,814,004	$359,070,021	$718,140,042
Borough of Mountain Lakes	$1,183,405,498	$11,834,055	$59,170,275	$118,340,550
Netcong Borough	$695,081,980	$6,950,820	$34,754,099	$69,508,198
Township of Parsippany-Troy Hills	$11,747,551,200	$117,475,512	$587,377,560	$1,174,755,120
Township of Pequannock	$3,911,039,941	$39,110,399	$195,551,997	$391,103,994
Township of Randolph	$6,709,486,516	$67,094,865	$335,474,326	$670,948,652
Borough of Riverdale	$1,165,082,666	$11,650,827	$58,254,133	$116,508,267
Borough of Rockaway	$1,612,749,951	$16,127,500	$80,637,498	$161,274,995
Township of Rockaway	$7,225,058,745	$72,250,587	$361,252,937	$722,505,875
Township of Roxbury	$5,918,169,131	$59,181,691	$295,908,457	$591,816,913
Borough of Victory Gardens	$163,035,099	$1,630,351	$8,151,755	$16,303,510
Township of Washington	$5,265,032,309	$52,650,323	$263,251,615	$526,503,231
Borough of Wharton	$1,539,335,501	$15,393,355	$76,966,775	$153,933,550
Morris County (Total)	**$127,068,881,137**	**$1,270,688,811**	**$6,353,444,057**	**$12,706,888,114**

Source: NJOIT 2018; Morris County 2019; 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.

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.

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. In 2016, 23 states within the US spent over $1.1 billion in winter maintenance costs (The Weather Channel 2016). Most recently for the 2018-2019 winter season, the State of New Jersey Department of Transportation has budgeted winter maintenance expenditures at $95.1 million, which includes costs for salt (284,423 tons), liquid calcium chloride (614,153 gallons), and brine (1,993,552 gallons) (NJDOT 2019).

Impact on the 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 (USGS nd). 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.

Furthermore, chemically based winter maintenance practices have its own effect on the natural environment. Melting snow and ice that carry deicing chemicals onto vegetation and into soils can contaminate the local waterways. Elevated salt levels may hinder vegetation from absorbing nutrients, slowing plant growth (The Environmental Literacy Council 2015).

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 Morris 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

As discussed in Section 3 (County Profile), the Morris County population has been increasing and is projected to continue to increase in coming decades. In addition, the population is aging. As the aging population grows, so too will the number of persons vulnerable to severe winter weather and extreme cold temperatures.

Climate Change

As discussed earlier, it is uncertain how climate change will influence extreme winter weather. 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 Since the 2015 HMP

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.