SOMERSET COUNTY

HAZARD MITIGATION PLAN

SOMERSET COUNTY MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

FINAL PLAN UPDATE
JULY 2019

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Section 5.4.2: RISK ASSESSMENT- SEVERE WINTER STORM

Prepared by the Somerset County Mitigation Planning Committee

5.4.2 SEVERE WINTER STORM

This section provides a profile and vulnerability assessment for the severe winter storm hazard.

HAZARD PROFILE

This section provides profile information including description, extent, location, previous occurrences and losses and the probability of future occurrences.

Description

For the purpose of this HMP, as deemed appropriate by Somerset County, and per the State of New Jersey Hazard Mitigation Plan (NJ HMP), winter weather events include snow storms, ice storms, cold waves and wind chill with snow storms being "the most obvious manifestation of winter weather." Since most extra-tropical cyclones (mid-Atlantic cyclones locally known as Northeasters or Nor'easters), generally take place during the winter weather months (with some events being an exception), these hazards have also been grouped as a type of severe winter weather storm. These types of winter events or conditions are further defined below.

Heavy Snow: According to the National Weather Service (NWS), heavy snow is generally snowfall accumulating to 4 inches or more in depth in 12 hours or less; or snowfall accumulating to six inches or more in depth in 24 hours or less. A snow squall is an intense, but limited duration, period of moderate to heavy snowfall, also known as a snowstorm, accompanied by strong, gusty surface winds and possibly lightning (generally moderate to heavy snow showers) (NWS, 2005). Snowstorms are complex phenomena involving heavy snow and winds, whose impact can be affected by a great many factors, including a region's climatologically susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, and occurrence during the course of the day, weekday versus weekend, and time of season (Kocin and Uccellini, 2011).

Blizzard: Blizzards are characterized by low temperatures, wind gusts of 35 miles per hour (mph) or more and falling and/or blowing snow that reduces visibility to ¼-mile or less for an extended period of time (three or more hours) (NWS, 2005).

Sleet or Freezing Rain Storm: Sleet is defined as pellets of ice composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes. These pellets of ice usually bounce after hitting the ground or other hard surfaces. Freezing rain is rain that falls as a liquid but freezes into glaze upon contact with the ground. Both types of precipitation, even in small accumulations, can cause significant hazards to a community (NWS, 2005).

Ice storm: An ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous, and can create extreme hazards to motorists and pedestrians (NWS, 2005).

Extra-Tropical Cyclone: Extra-tropical cyclones, sometimes called mid-latitude cyclones, are a group of cyclones defined as synoptic scale, low pressure, weather systems that occur in the middle latitudes of the Earth. These storms have neither tropical nor polar characteristics and are connected with fronts and horizontal gradients in temperature and dew point otherwise known as "baroclinic zones".

Extra-tropical cyclones are everyday weather phenomena which, along with anticyclones, drive the weather over much of the Earth. These cyclones produce impacts ranging from cloudiness and mild showers to heavy gales and thunderstorms. Tropical cyclones often transform into extra-tropical cyclones at the end of their tropical existence, usually between 30 degrees (°) and 40° latitude, where there is sufficient force from upper-level shortwave troughs riding the westerlies (weather systems moving west to east) for the process of extra-tropical transition to begin. A shortwave trough is a disturbance in the mid or upper part of the atmosphere which induces upward motion ahead of it. During an extra-tropical transition, a cyclone begins to tilt back into the colder air mass with height, and the cyclone's primary energy source converts from the release of latent heat from condensation (from thunderstorms near the center) to baroclinic processes (Canadian Hurricane Centre [CHC], 2003).

Nor'easter (abbreviation for Northeaster): Nor'easters are named for the strong northeasterly winds that blow in from the ocean ahead of the storm and over coastal areas. They are also referred to as a type of extra-tropical cyclones (mid-latitude storms, or Great Lake storms). A Nor'easter is a macro-scale extra-tropical storm whose winds come from the northeast, especially in the coastal areas of the northeastern U.S. and Atlantic Canada. Wind gusts associated with Nor'easters can exceed hurricane forces in intensity. Unlike tropical cyclones that form in the tropics and have warm cores (including tropical depressions, tropical storms and hurricanes); Nor'easters contain a cold core of low barometric pressure that forms in the mid-latitudes. Their strongest winds are close to the earth's surface and often measure several hundred miles across. Nor'easters may occur at any time of the year but are more common during fall and winter months (September through April) (NYCOEM, 2008).

Nor'easters can cause heavy snow, rain, gale force winds and oversized waves (storm surge) that can cause beach erosion, coastal flooding, structural damage, power outages and unsafe human conditions. If a Nor'easter cyclone stays just offshore, the results are much more devastating than if the cyclone travels up the coast on an inland track. Nor'easters that stay inland are generally weaker and usually cause strong winds and rain. The ones that stay offshore can bring heavy snow, blizzards, ice, strong winds, high waves, and severe beach erosion. In these storms, the warmer air is aloft. Precipitation falling from this warm air moves into the colder air at the surface, causing crippling sleet or freezing rain (McNoldy [Multi-Community Environmental Storm Observatory (MESO)], 1998-2007). While some of the most devastating effects of Nor'easters are experienced in coastal areas (e.g. beach erosion, coastal flooding), the effects on inland areas, like Somerset County, may include heavy snow, strong winds and blizzards.

Winter storms can also generate coastal flooding, ice jams and snow melt, resulting in significant damage and loss of life. Coastal floods are caused when the winds generated from intense winter storms cause widespread tidal flooding and severe beach erosion along coastal areas. Ice jams are caused when long cold spells freeze up rivers and lakes. A rise in the water level or a thaw breaks the ice into large chunks. These chunks become jammed at man-made and natural obstructions. The ice jams act as a dam and result in flooding (NSSL, 2006).

Extent

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

The extent of a severe winter storm can be classified by meteorological measurements, such as those above, and by evaluating its societal impacts. The Northeast Snowfall Impact Scale (NESIS) categorizes snowstorms, including Nor'Easter events, in this manner. Unlike the Fujita Scale (tornado) and Saffir-Simpson Scale (hurricanes), there is no widely used scale to classify snowstorms. NESIS was developed by Paul Kocin of The Weather Channel and Louis Uccellini of the NWS to characterize and rank high-impact, northeast snowstorms. These storms have large areas of 10 inch snowfall accumulations and greater. NESIS has five ranking categories: Notable (1), Significant (2), Major (3), Crippling (4), and Extreme (5) (Table 5.4.2-1). The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus, NESIS gives an indication of a storm's societal impacts. This scale was developed because of the impact northeast snowstorms can have on the rest of the country in terms of transportation and economic impact (Kocin and Uccellini, 2011).

Table 5.4.2-1 NESIS Ranking Categories 1 - 5

Category	Description	NESIS Range	Definition
1	Notable	1.0 – 2.49	These storms are notable for their large areas of 4-inch accumulations and small areas of 10-inch snowfall.
2	Significant	2.5 – 3.99	Includes storms that produce significant areas of greater than 10-inch snows while some include small areas of 20-inch snowfalls. A few cases may even include relatively small areas of very heavy snowfall accumulations (greater than 30 inches).
3	Major	4.0 – 5.99	This category encompasses the typical major Northeast snowstorm, with large areas of 10-inch snows (generally between 50 and 150 × 103 mi^2—roughly one to three times the size of New York State with significant areas of 20-inch accumulations.
4	Crippling	6.0 – 9.99	These storms consist of some of the most widespread, heavy snows of the sample and can be best described as crippling to the northeast U.S, with the impact to transportation and the economy felt throughout the United States. These storms encompass huge areas of 10-inch snowfalls, and each case is marked by large areas of 20-inch and greater snowfall accumulations.
5	Extreme	10 +	The storms represent those with the most extreme snowfall distributions, blanketing large areas and populations with snowfalls greater than 10, 20, and 30 inches. These are the only storms in which the 10-inch accumulations exceed 200 × 103 mi^2 and affect more than 60 million people.

Source: Kocin and Uccellini, 2004

NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. These numbers are calculated into a raw data number ranking from "1" for an insignificant fall to over "10" for a massive snowstorm. Based on these raw numbers, the storm is placed into its decided category. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers (Enloe, 2011).

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 U.S. The RSI ranks snowstorm impacts on a scale from one to five, which is similar to the Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes. The RSI differs from the NESIS because it includes population. 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) (NOAA-NCDC, 2017). Table 5.4.2-2 explains the five categories:

Table 5.4.2-2 RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCDC, 2017 (http://www.ncdc.noaa.gov/snow-and-ice/rsi/)

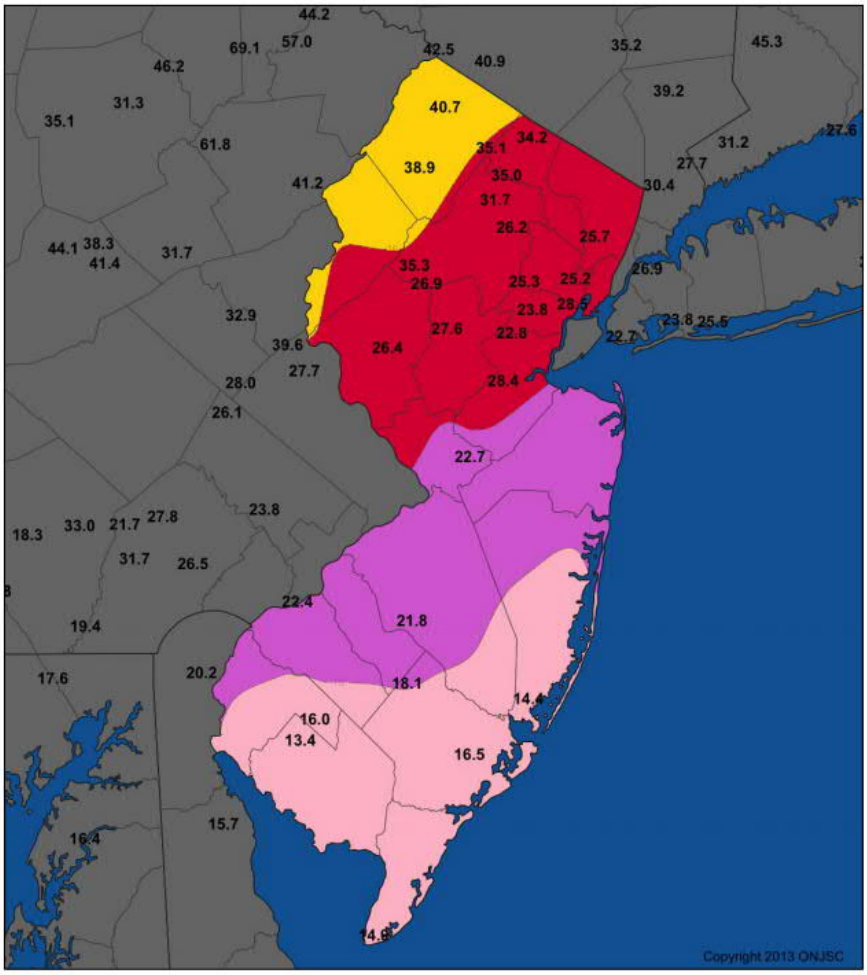
The indices for RSI are calculated similar to those for NESIS; however, the new indices require region-specific parameters and thresholds for the calculations. The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC, 2017).

Location

Winter weather, particularly snowstorm events, has historically affected many U.S. states, mainly in the states located in the Northeast and Midwest, including all of New Jersey. Winter weather can reach the state as early as October and is usually in full force by late November with average winter temperatures average between 20 and 40^{o} F.

As indicated in the NJ HMP, winter storm hazards in New Jersey are guaranteed annually from late November to March, including ice storms. The zone of heaviest snowfall across New Jersey usually occurs in the southwest-to-northeast strip about 150 miles wide, approximately parallel to the path of the storm center, and about 125 and 175 miles northwest of it. If the center passes well offshore, only south Jersey receives substantial snowfall. When the track passes close to shore, warm air from the ocean is drawn into the surface circulation, resulting in rain falling over south Jersey and snow over the rest of the State. Often, a passing storm center brings rain to the south, mixed precipitation to central sections and snow to the north. Average annual snowfall in New Jersey varies greatly from year to year, east to west, and north to south ranging from a minimum of about 15 inches in Cape May County to a maximum of over 40 inches in Sussex County (NJOEM, 2014). The average annual snowfall is greater than 24 inches over much of New Jersey's central and northern area; including Somerset County (Figure 5.4.2-1).

Figure 5.4.2-1 Normal Seasonal Snowfall in New Jersey, 1981-2010



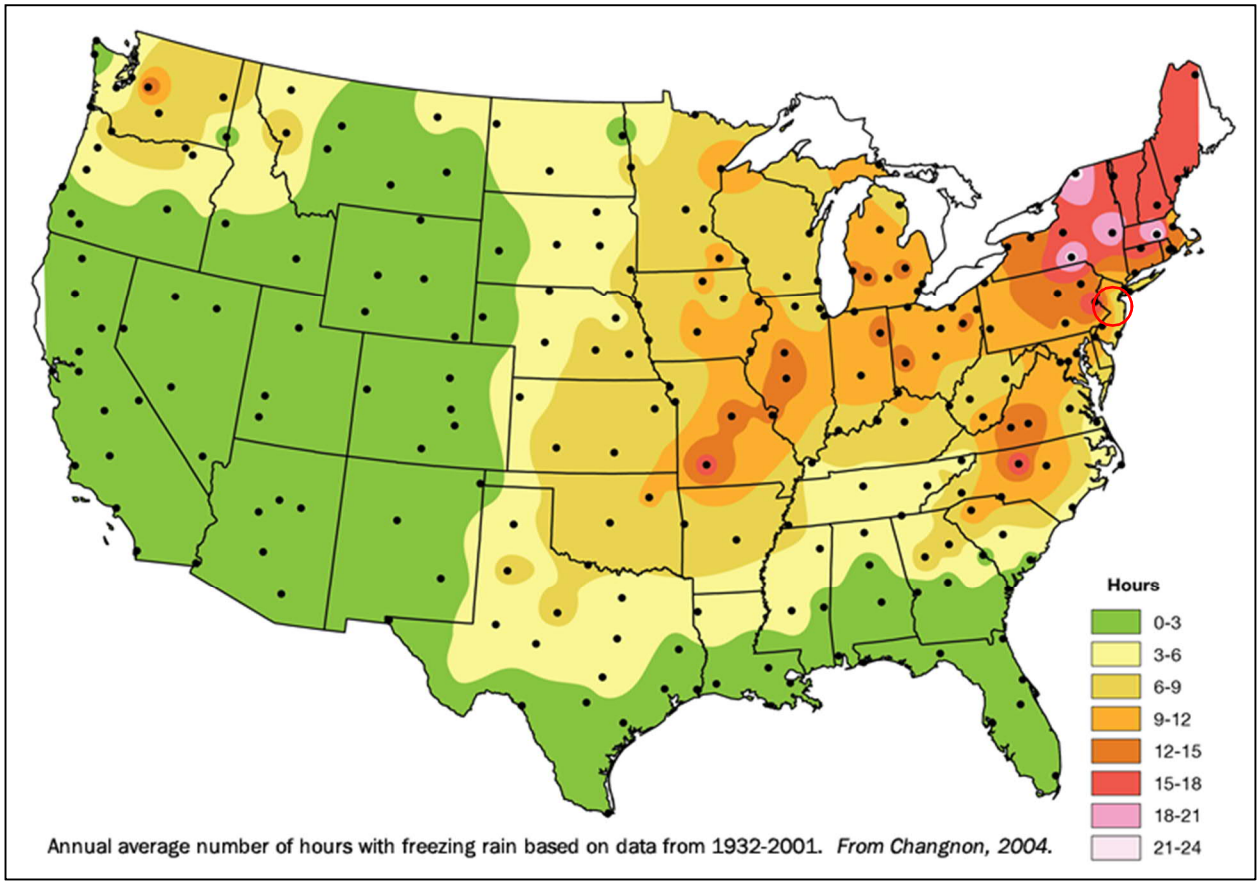
Source: ONJSC Rutgers University 2013a
Note: The numbers on the map represent the normal seasonal snowfall totals in inches.

Most extreme snowfall events occur as the result of extremely strong low pressure systems moving to the north, northeast off of the coast of New Jersey from early winter through mid-spring. If the conditions are ideal, these coastal lows transport Atlantic moisture over a cold layer of air over New Jersey resulting in extremely high snowfall rates and occasionally blizzard conditions (NJOEM, 2011).

In many parts of New Jersey, the distribution of ice storms coincides with the general distribution of snow, and their occurrence similarly depends on regional pressure distribution and local weather conditions. Therefore, the entire state of New Jersey is susceptible to ice storms (NJOEM, 2011). However, areas experiencing lower temperatures are more susceptible to all winter storms. Interestingly, this can mean that areas at higher elevations with colder air may experience more ice and freezing rain than their neighbors in a lower valley; but in other cases it is the lowlands that experience ice storms when cold air gets trapped in the valleys of regions with more significant topographical change (NJOEM, 2011).

Figure 5.4.2-3 illustrates the average number of hours per year with freezing rain in the U.S. According to the figure, Somerset County experiences between 6 and 12 hours per year (MRCC, 2017).

Figure 5.4.2-3 Average Number of Hours per Year with Freezing Rain in the United States



Source: MRCC, 2017
Note: Somerset County is located in an area with an average number of 6 to 12 hours of freezing rain each year.

Nor'easters have the potential to cause as much damage as hurricanes and other tropical cyclone storms in New Jersey's latitudes, with powerful winds, rain or snow and large waves. They can pound and erode beaches with heavy surf, affect inland areas with flooding, or coat the land with thick layers of ice and snow. Nor'easters result from the counterclockwise rotation of a low-pressure system and the clockwise rotation of a high-pressure system, combining to send wind and moisture to New Jersey from the Northeast. The Nor'easters ferocity will depend on the strength of the two systems. One reason Nor'easters are so dangerous is that they tend to move much more slowly than hurricanes at our latitudes. That slow movement allows the storm's effects to accumulate in a given area. The worst disasters in New Jersey history, in terms of cost and widespread damage, have been from Nor'easters that moved slowly and remained for several days. Nor'easters can occur all year long, but in New Jersey they are primarily a risk between September and April (NJOEM, 2017.).

Somerset County has an abundance of riverine waters which receive runoff from many tributaries, and the flooding generally associated with some Nor'easters can indirectly affect the entire County with cascading floodwaters, particularly impacting communities along the major rivers of the County, such as the Borough of Bound Brook along the Raritan River and the Borough of Manville within the vicinity of the Raritan and Millstone Rivers. The County has felt the direct and indirect landward effects, including high winds, heavy rains, riverine and flash flooding and has suffered millions of dollars in losses associated with several Nor'easters in recent history. This includes a federally declared disaster event that

occurred in April 2007, which is further discussed in this profile in Section 5.4.3 (Flood). If heavy snow accompanies a Nor'easter event, it becomes more of a regional impact rather than a county-specific event.

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with severe winter storms and extreme cold events throughout the State of New Jersey and Somerset County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

According to NOAA's NCDC storm events database, Somerset County experienced 188 severe winter weather events between January 1996 and September 2017. Total property damages, as a result of only five of these winter storm events, were estimated at $7.6 million. Only $100,000 of these damages were recorded in the five years since the last plan was prepared (and

Between 1955 and 2017, FEMA declared that the state of New Jersey experienced 13 winter storm-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: winter storms, severe storms, coastal storms, ice storm, blizzard, snow, snowstorm, nor'easter and flooding. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations. Of those events, Somerset County has been declared as a disaster area as a result of five winter storm-related events (FEMA and NJOEM, 2017). In some cases, what FEMA may classify as a severe storm or coastal storm event, various other sources including the NJ HMP and NJOEM indicate that they were identified as nor'easter events, which are further identified in Table 5.4.2-3.

Although Somerset County may have not been listed as an official FEMA disaster area for all of the events identified in New Jersey, Somerset County may have still experienced indirect or cascading losses or impacts associated with the events. Because flooding was the primary result of some of these hazard events, the severe flooding impact of major events are also mentioned in Section 5.4.3 (Flood).

Based on all sources researched, known winter storm events that have affected Somerset County and its municipalities are identified in Table 5.4.2-3. With winter storm documentation for New Jersey being so extensive, not all sources have been identified or researched. Therefore, Table 5.4.2-3 may not include all events that have occurred throughout the County and region.

Table 5.4.2-3 Winter Storm Events Between 1888 and 2017

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
March 11-14, 1888	Blizzard (Blizzard of '88 or "Great White Hurricane")	N/A	N/A	$25 M nationwide in fire losses, over 400 deaths reported; NJ snowbound, extreme cold temperatures; reports of 20 to 30 inches of snow fell in Somerset County	Somerset County HMP
February 11-14, 1899	Snowstorm	N/A	N/A	Somerset County experienced 20 to 30 inches of snow.	Somerset County HMP
December 25-27, 1947	Snowstorm	N/A	N/A	Somerset County experienced 10 to 30 inches of snow.	Somerset County HMP
February 15-17, 1958	Snowstorm	N/A	N/A	Approximately 21 inches of snow in northern New Jersey	Somerset County HMP
March 18-21, 1958	Snowstorm	N/A	N/A	Somerset County experienced 10 to 30 inches of snow.	Somerset County HMP
March 2-5, 1960	Snowstorm	N/A	N/A	Somerset County experienced 10 to 20 inches of snow. SHELDUS indicated that Somerset County experienced $2.4 K in damages	Somerset County HMP
December 11-13, 1960	Snowstorm	N/A	N/A	Somerset County experienced 10 to 30 inches of snow.	Somerset County HMP
February 2-5, 1961	Snowstorm	N/A	N/A	Approximately 27 inches of snow in northern New Jersey; $2.4 K in property damage for Somerset County. Somerset County experienced 10 to 30 inches of snow.	Somerset County HMP
March 9, 1962	Nor'easter	DR-124	Not available	The most damaging northeast storm since the 1888 Blizzard struck New Jersey. Although this storm did not produce record surge levels, it inflicted substantially greater overall damages and loss of life than any other storm. This was primarily due to the prolonged duration of the storm that caused damaging over wash and flooding through five successive high tides. Increased development along the coast since the 1944 hurricane also accounted for increased damages. This storm was also responsible for the loss of 22 lives, completely destroyed 1,853 homes and caused major damage to approximately 2,000 additional homes. The total damage caused by this storm to public and private property was about $85 million (1962 dollars).	NJ HMP 2014

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
January 11-14, 1964	Snowstorm	N/A	N/A	Blizzard and near-blizzard conditions in northeast, traffic disrupted for several days, snow accumulations of over a foot in some areas; approximately 10-20 inches of snow in Somerset County	Somerset County HMP
December 16, 1973	Snowstorm	N/A	N/A	Somerset County experienced $23.8 K in damages	Somerset County HMP
February 8, 1977	Ice Storm	DR-528	Not available	State of NJ was declared; individual county declaration data and impacts not available.	NJ HMP 2014
February 5-7, 1978	Snowstorm	N/A	N/A	Somerset County experienced 10 to 20 inches of snow.	Somerset County HMP
February 10-12, 1983	Snowstorm ("Megalopolitan Snowstorm")	N/A	N/A	Occurred during one of the strongest El Niños in 20th century. Snowfall totals for Somerset County ranged between 20 to 30 inches	Somerset County HMP
October 28, 1991	Nor'easter	N/A	N/A	This Halloween nor'easter, also known as the "Perfect Storm", affected primarily coastal counties in NJ with waves of up to 30 feet in height, high tides, and intense winds with damages of about $90 million (in 1991 dollars).	NJ HMP 2014
January 4, 1992	Nor'easter	DR-936	No	$4.85 million in Public Assistance for Ocean, Monmouth, Atlantic, Cape May, and Cumberland Counties	www.state.nj.us/njoem Summary of Presidentially-Declared Disaster/Emergencies Impacting New Jersey, 1992 to present
December 11-13, 1992	Coastal Storm, High Tides, Heavy Rain, Flooding (identified as a Nor'easter)	DR-973	Yes (IA and PA)	Bergen, Essex, Hudson, Somerset, Union, Middlesex, Monmouth, Ocean, Salem, Atlantic, Cumberland, and Cape May Counties were declared disaster areas. Total damages for this event were estimated at $2 B. Nearly $350 M was paid on more than 25,000 flood- insured losses resulting from this storm. Total eligible amount: $51.0 M Public Assistance (25% state share $12.5 M); $10.5 M Individual Assistance (25% state share $1.32 M); $ 2.2 M Hazard Mitigation (50/50 share). NJOEM indicated that 238 municipalities were eligible for Public Assistance in New Jersey. Although Somerset County was declared as a disaster area from this event, information regarding losses or impacts for Somerset County is scarce.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
March 12-15, 1993	Severe Blizzard ("Storm of the Century")	EM-3106 / DR-3106	Yes (PA only)	Listed as a top billion dollar weather disaster, the storm impacted 26 states and resulted in approximately $3 B in damages. FEMA declared an EM in 17 states, including all of NJ; $2.6 M in assistance designated for snow plowing activities (includes 25% state share). Somerset County experienced 10 to 20 inches of snow. The type of damage, monetary losses and location were not reported for Somerset County.	Somerset County HMP
February 8-12, 1994	Snowstorm	N/A	N/A	Total snow accumulations ranged between six inches and two feet throughout the northeast U.S., two fatalities reported in New Jersey, storm disrupted air, rail, and highway travel, many people lost power; Snow totals for Somerset County ranged from six to 12 inches	Somerset County HMP
January 6-8, 1996	Blizzard ("Blizzard of '96") (Also identified as a Nor'Easter)	DR-1088	Yes (PA only)	Total snow accumulations for the eastern U.S. range from one to three feet. New Jersey reported four fatalities; Somerset County experienced 15 to 30 inches of snow, $42 M in disaster aid to New Jersey; SHELDUS indicated that Somerset County experienced $1.4 M in damages. $4.4 Million in damages in Somerset County are recorded in NOAA's NCDC event record.	Somerset County HMP
October 18-23, 1996	Severe Storms / Flooding (also identified as a Nor'easter by the NJ HMP)	DR-1145	Yes (IA only)	NJOEM calls this the "Raritan River Flood Event," because the Raritan reached record levels during this storm. Rainfall amounts ranged from 4 to 8 inches throughout Somerset County. Caused approx. $31 M in property damages in Somerset County. Evacuations in Manville Borough and the Hamlet of North Branch, flooded basements, foundations collapsed. For New Jersey State - Individual Assistance, Hazard Mitigation, FEMA Disaster Housing Assistance $1.6 M; Individual/Family Grant Program $249 K (includes 25% state share); SBA Loans $1.2 M; Federal Hazard Mitigation Funding $256 K. According to NOAA-NCDC, Somerset County experienced approx. $31 M in property damages, primarily from flooding.	Somerset County HMP
March 31, 1997	Heavy Snow	N/A	N/A	Season high snow accumulations to sections of Hunterdon, Somerset, Mercer and Burlington Counties. In Somerset County, the Borough of Bernardsville was hit the hardest with up to 30 trees down that forced 6 road closures. 8 to 9 inches in the unincorporated community of Pottersville and the Borough of Somerville.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
February 1998	Severe Nor'easter	DR-1206	No	Impacted mainly Atlantic, Cape May, and Ocean counties; $2.2 M in FEMA Public assistance Program; $1.1 Million Disaster Housing Program; $88k Individual/Family Grant Program; $477k Hazard Mitigation Grant Program	www.state.nj.us/njoem Summary of Presidentially-Declared Disaster/Emergencies Impacting New Jersey, 1992 to present
January 13-15, 1999	Snowstorm	N/A	N/A	25 injuries resulted. Hardest hit in central New Jersey were Middlesex and Somerset Counties with 17,000 power outages	NOAA-NCDC
December 30-31, 2000	Snowstorm ("End of Millennium Snowstorm")	N/A	N/A	Snowfall rates of 2 to 3 inches per hour, Somerset County snowfall totals ranged from 12 to 27 inches	Somerset County HMP
February 14-18, 2003	Blizzard ("President's Day Blizzard")	EM-3181	Yes (PA only)	FEMA provided assistance to all counties in New Jersey; Storm caused 20 deaths nationwide, over a foot of snow fell in New Jersey, $30 M spent for cleaning roads in New Jersey; the State declared a state of emergency. NOAA indicated that this event resulted in $8 M in damages, one fatality and eight injuries. Snowfall totals ranged from 15 to 22 inches in Somerset County. SHELDUS indicated that Somerset County experienced $1 M in damages	Somerset County HMP
January 22-23, 2005	Blizzard	N/A	N/A	Heaviest snow storm since 2003. NOAA-NCDC indicated that this event resulted in $2 M in damages. Snowfall totals averaged 11 to 16.5 inches in Somerset County. SHELDUS indicates that Somerset County experienced $1.6 M in damages.	Somerset County HMP
February 11-12, 2006	Snowstorm	N/A	N/A	Record snowfall reported for most areas in New Jersey. Somerset County received 13 to 19 inches of snow.	Somerset County HMP
April 14-16, 2007	Severe Storm and Coastal Flooding (also identified as a Nor'easter)	DR-1694	Yes (IA and PA)	This storm created the 2nd largest flood event in Somerset County. The seven-day rainfall total for the County ranged from eight to 10 inches. USGS indicated that the North and South Branches of the Raritan River and the Raritan River had 20-year events. Millstone River had an 80-year event. Governor Codey declared a state of emergency for New Jersey. State Officials estimated that the State experienced over $180 M in property damages. As of June 11, 2007, nearly $31 M in federal grants for flood losses has been approved for New Jersey residents. Bound Brook Borough was one of the hardest hit communities and was given $5.2 M in federal aid.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
December 19 - 20, 2009	Snowstorm	DR-1873	No	A major winter storm dropped heavy snow across most of New Jersey. Snowfall averaged 6 to 12 inches across northwest New Jersey and the Raritan Basin and 12 to 24 inches across central and southern New Jersey. Snow began around Noon in the Raritan Basin and mixed with sleet at times during the day on the 19th. The snow fell at its heaviest between the afternoon and early evening, and lingered through 8 a.m. on the 20th. The winter storm came at an inopportune time for retailers as the Saturday (the 19th) before Christmas is usually one of the busiest shopping days of the year. The storm left motorists stranded, caused accidents, school closures, delayed public services and interrupted public transit. Representative snowfall in Somerset County included 9.5 inches in Hillsborough Township and 7.7 inches at Bound Brook Borough. No damages were reported in Somerset County.	FEMA, NOAA-NCDC, NWS
February 5 - 6, 2010	Severe Winter Storm and Snowstorm	DR-1889	No	A major winter storm dropped 10 to 20 inches across central of New Jersey from the afternoon of the 5th into the afternoon of the 6th. Many county and municipalities declared snow emergencies. On March 23, President Barack Obama declared Atlantic, Burlington, Cape May, Camden, Cumberland, Gloucester and Salem Counties a Major Disaster Area. About 100,000 homes and businesses lost power in the state. Some roads and highways were impassable, speed limits were reduced, and Amtrak canceled train service. Where the snow was relatively lighter, more accidents and fender benders were reported. Representative snowfall in Somerset County included 6.8 inches in the Hillsborough Township, 5.5 inches in Bridgewater Township, and 5 inches in Bound Brook Borough. No damage was reported in Somerset County.	FEMA, NOAA-NCDC, NWS

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
March 12 - April 15, 2010	Severe Storms and Flooding	DR-1897	Yes (IA and PA)	A Nor'Easter moved into the area on March 12. On March 13, strong to high winds downed thousands of trees and tree limbs, hundreds of telephone poles, and caused utility outages throughout the state. The strongest winds occurred during the afternoon on the 13th. Governor Chris Christie declared a state of emergency on the 14th, and on the 26th requested a major disaster declaration, which was announced on April 2. At the time of this report, a total $16.9M in IA had been approved and $30.7M in PA had been obligated throughout the State of New Jersey. In Somerset County, peak wind gusts reached 45 mph Bridgewater Township, and max wind speeds of 53 mph were recorded in Hillsborough Township. In Hillsborough Township, 3.11 inches of rain fell on the 13th. Tremendous tree damage occurred in Montgomery Township. Schools were closed on the 15th as six roadways were still closed. Downed trees closed roads in Bernards Township, Benardsville Borough, and Far Hills Borough. NOAA-NCDC reported approximately $5K in damages for Somerset County, while SHELDUS reported over $15M in damages, mostly due to storm-induced flooding in the County.	FEMA, NOAA-NCDC, SHELDUS
December 26-27, 2010	Severe Winter Storm and Snowstorm	DR-1954	Yes	Fifteen of NJ's 21 counties were declared during this event. FEMA Public Assistance grant dollars obligated totaled $52.4 M. Storm totals in Somerset County ranged from a minimum of 4.5 inches in Pottersville, to a maximum of 22.5 inches in Somerset.	FEMA, NWS

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
October 29, 2011	Severe Storm/Winter Storm	DR-4048	Yes (PA)	A winter storm dropped heavy snow across parts of central and all of northwest New Jersey. Across the Raritan Basins precipitation changed from rain to snow by 11 a.m. in most places, falling heavy at times until 5 p.m. As precipitation became lighter, it mixed with some sleet and rain, ending late that evening. In the Raritan Basin accumulations averaged 3 to 7 inches. Over 800,000 utility customers in the state lost power, not fully restored until Nov. 4th. On November 30, President Obama declared a state-wide major disaster declaration. According to FEMA's preliminary damage assessment, the storm's primary impact was costs associated with debris removal. Total public assistance cost estimate state-wide was $22,258,367, with a countywide per capita impact in Somerset County of $10.62. In Somerset County, three separate sections of Interstate 287 were closed. Some schools were closed on 31st. Commuter rail service was suspended along the Morris and Essex Lines. Representative snowfall included 5.0 inches and 4.8 inches in Bridgewater Township, 1.6 inches in Bound Brook Borough, and 1.7 inches in Hillsborough Township.	FEMA, NOAA-NCDC, NWS

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
October 26 - November 8, 2012	Hurricane Sandy	DR-4086/EM-3354	Yes (IA and PA)	Hurricane Sandy made landfall in New Jersey on October 28, causing widespread damage. Sustained winds were well over tropical storm force in northern and central New Jersey, and gusts exceeded hurricane force (74 mph) at many coastal locations and at some exposed inland sites. The result of the storm was devastation to homes and infrastructure along portions of the northern and central coast, thousands of trees falling on homes, automobiles, and power lines across the state, unprecedented damage to the power grid, the loss of power to over 75% of customers, and record disruptions of transportation and communications. A federal emergency declaration was announced for New Jersey on October 29, and a major disaster declaration followed the next day, making IA and PA funds available to affected residents. Only a week after Sandy made landfall in New Jersey, a Nor'Easter hit the area on November 7. Much of the State experienced wet snow which weighed down power lines and caused tree limbs to snap, significantly adding on to the existing power outages throughout the State. Additionally, some areas experienced 60 mph wind gusts. At the time of this report, a total $274.9M in IA had been approved and $81M in PA had been obligated throughout the State of New Jersey. In Somerset County, max wind speeds were recorded at 44 mph in Hillsborough Township. Approximately 1.42 inches of rain fell in the Township as well.	FEMA, NOAA-NCDC, ONJSC
February 12, 2014	Winter Storm	N/A	N/A	Snow, sleet and freezing rain across most of NJ, with storm totals of 10 to 20 inches across most of the I-95 corridor. The weight of the snow started to cause structural damage. In Raritan (Somerset County), strip mall roofing collapsed on U.S. Route 202. No injuries occurred.	NOAA NCDC
January 22-24, 2016	Severe Winter Storm and Snowstorm (Blizzard)	DR-4264	Yes	All but four of NJ's 21 counties were declared during this event. Over $73 million of FEMA Public Assistance grant dollars were obligated. Record snowfall occurred across most of the state. In Somerset County, snowfall totals included 30.0 inches in Bernards Township, 28.0 inches in Bound Brook, 27.4 inches in Somerville, 25.0 inches in Greenbrook Township, 24.0 inches in Franklin Township, 23.0 inches in Warren Township, 20.7 inches in Hillsborough,	FEMA, NOAA NCDC

Sources: NOAA-NCDC, FEMA, NWS, SHELDUS, Somerset County HMP

Note: Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of inflation.

DR	Disaster Declaration
EM	Emergency Declaration
FEMA	Federal Emergency Management Agency
IA	Individual Assistance
K	Thousand ($)
M	Million ($)
N/A	Not Applicable
NCDC	National Climatic Data Center
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
ONJSC	Office of the New Jersey State Climatologist
PA	Public Assistance
SBA	Small Business Administration
SHELDUS	Spatial Hazard Events and Losses Database for the United States

Probability of Future Events

According to the NJ HMP, winter storms are frequent events for the State and occur from late November until March. Because of New Jersey's northern location at a climactic crossroads and its distinctive geography, it experiences the full effect of the winter season. Normally experiencing lower temperatures on most winter days, the north has a greater chance of all types of winter storms occurring, which includes all of Somerset County (NJOEM, 2011).

It is estimated that Somerset County will continue to experience direct and indirect impacts of severe winter storms annually. Table 5.4.2-4 summarizes the occurrences of winter storm event types as recorded by NOAA NCDC and their annual occurrence (on average).

Table 5.4.2-4 Occurrences of Severe Winter Storm Events in Somerset County, 1996 - 2017

Event Type	Total Number of Occurrences	Annual Number of Events (average)
Blizzard	2	0.10
Heavy Snow	32	1.52
Ice Storm	2	0.10
Winter Storm	34	1.62
Winter Weather	124	5.90
Total:	**194**	**9.24**

Source: NOAA-NCDC, 2017

Note: NOAA NCDC event records cannot be queried specifically for nor'easters. Hazards associated with Nor'easters may be counted under Snow/Ice Storm or Winter Weather, based on the NOAA-NCDC Storm Database Hazard of record. Hazards associated with Nor'easters not labeled as a severe winter storm event were recorded by NOAA-NCDC under the following hazard types: High Wind, Coastal Flooding, Freezing Rain, and Strong Wind. According to the NJ HMP 2014, 16 nor'easters were recorded between 1991 and 2013 (0.72 nor'easters per year).

The identified hazards of concern for Somerset County are ranked in Section 5.3. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the County Planning Mitigation Committee, the probability of occurrence for severe winter storms in Somerset County is considered (frequent as presented in Table 5.3-3) and impacts only related to severe winter storms, excluding those associated with hurricanes, tropical storms, and flooding, are expected to be medium.

It is estimated that Somerset County and all of its jurisdictions, will continue to experience direct and indirect impacts of severe winter storms annually that may induce secondary hazards such as flooding, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

Nor'easters

Analysis of nor'easter frequency by researchers reveals that fewer nor'easters occurred during the 1980s. However, the frequency of major nor'easters (class 4 and 5 on the Dolan-Davis Scale) has increased in recent years. In the period of 1987 to 1993, at least one class 4 or 5 storm has occurred each year along the Atlantic coast, a situation duplicated only once in the last 50 years (North Carolina Department of Public Safety, 2009).

Nor'easters are expected to occur in one out of every four winters (NJ HMP, 2014). They have the potential to inflict more damage than many hurricanes, not only because their diameter is often three to four times larger than the average hurricane (making their area of impact much more widespread) but also

because of their long-duration heavy winds which can last from 12 hours to three days. Infrastructure, including critical facilities, may be impacted by these events, and power outages and transportation disruptions (for example: snow, heavy rain and/or debris impacted roads, as well as hazards to navigation and aviation) are often associated with nor'easters and other winter storms (NJ HMP 2014). All areas of Somerset County are potentially at risk for property damage and loss of life due to nor'easters; therefore, having a moderate to high probability for nor'easters to occur.

NOAA NCDC event records cannot be queried specifically for nor'easters. According to the NJ HMP 2014, 16 nor'easters were recorded in New Jersey between 1991 and 2013 (0.72 nor'easters per year).

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For severe winter storms, the entire 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, are vulnerable to a severe winter storm. The following text evaluates and estimates the potential impact of severe storms on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact, including: (1) impact on life, safety and health, (2) general building stock, (3) critical facilities, and (4) economy
- Further data collections that will assist understanding of this hazard over time
- Overall vulnerability conclusion

Overview of Vulnerability

Severe winter storms are of significant concern to Somerset County because of the frequency and magnitude of these events in the region, the direct and indirect costs associated with these events, delays caused by the storms, and impacts on the people and facilities of the region related to snow and ice removal, health problems, cascade effects such as utility failure (power outages) and traffic accidents, and stress on community resources.

Data and Methodology

HAZUS-MH population and building stock data were used to support an evaluation of assets exposed to this hazard and the potential impacts associated with this hazard. Additionally, economic losses were provided by Somerset County to support this vulnerability assessment.

Impact on Life, Health and Safety

According to the NOAA National Severe Storms Laboratory (NSSL), hundreds of people are killed each year in the U.S. during winter weather events, 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. Most injuries, fatalities, and other impacts or losses are indirectly related to the storm. They are most often a result of traffic accidents on icy roads, of 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, 2017).

Heavy snow can immobilize transportation systems, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NSSL, 2017).

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 (NSSL, 2017).

For the purposes of this HMP, the entire population of Somerset County (323,444 people) is exposed to severe winter storm events (U.S. Census, 2010). Snow accumulation and frozen/slippery road surfaces increase the frequency and impact of traffic accidents for the general population, resulting in personal injuries. Refer to Table 4-2 in the County Profile for population statistics for each participating municipality.

The elderly are considered most 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. In addition, severe winter storm events can reduce the ability of these populations to access emergency services. Residents with low incomes may not have access to housing or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply).

Impact on General Building Stock

The entire general building stock inventory in Somerset County 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. Table 5.4.2-5 presents the total exposure value for general building stock for each participating municipality (structure only).

There was no historic information available that identified property damages within Somerset County due to a single severe winter storm event. 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. Table 5.4.2-5 below summarizes percent damages that could result from severe winter storm conditions for the County's total general building stock (structure only). Given professional knowledge and information available, the potential losses for this hazard are considered to be overestimated.

Table 5.4.2-5 General Building Stock Exposure (Structure Only) and Estimated Losses from Severe Winter Storm Events in Somerset County

Municipality	Total (All Occupancies) RV	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Bedminster (T)	$1,679,153,000	$16,791,530	$83,957,650	$167,915,300
Bernards (T)	$4,043,773,000	$40,437,730	$202,188,650	$404,377,300
Bernardsville (B)	$1,263,029,000	$12,630,290	$63,151,450	$126,302,900
Bound Brook (B)	$1,024,459,000	$10,244,590	$51,222,950	$102,445,900
Branchburg (T)	$2,828,305,000	$28,283,050	$141,415,250	$282,830,500
Bridgewater (T)	$7,132,150,000	$71,321,500	$356,607,500	$713,215,000
Far Hills (B)	$161,190,000	$1,611,900	$8,059,500	$16,119,000

Municipality	Total (All Occupancies) RV	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Franklin (T)	$8,492,720,000	$84,927,200	$424,636,000	$849,272,000
Green Brook (T)	$1,153,646,000	$11,536,460	$57,682,300	$115,364,600
Hillsborough (T)	$2,207,785,000	$22,077,850	$110,389,250	$220,778,500
Manville (B)	$1,309,065,000	$13,090,650	$65,453,250	$130,906,500
Millstone (B)	$51,796,000	$517,960	$2,589,800	$5,179,600
Montgomery (T)	$3,309,079,000	$33,090,790	$165,453,950	$330,907,900
North Plainfield (B)	$2,242,474,000	$22,424,740	$112,123,700	$224,247,400
Peapack Gladstone (B)	$564,419,000	$5,644,190	$28,220,950	$56,441,900
Raritan (B)	$1,029,025,000	$10,290,250	$51,451,250	$102,902,500
Rocky Hill (B)	$115,133,000	$1,151,330	$5,756,650	$11,513,300
Somerville (B)	$1,766,099,000	$17,660,990	$88,304,950	$176,609,900
South Bound Brook (B)	$556,669,000	$5,566,690	$27,833,450	$55,666,900
Warren (T)	$2,562,281,000	$25,622,810	$128,114,050	$256,228,100
Watchung (B)	$925,710,000	$9,257,100	$46,285,500	$92,571,000
Somerset County	**$44,417,960,000**	**$444,179,600**	**$2,220,898,000**	**$4,441,796,000**

Source: Somerset GIS
Notes: RV = Replacement Cost Value. The building values shown are building structure only because damage from the severe winter storm hazard generally impact structures such as the roof and building frame (rather than building content). The evaluation of general building stock and the loss estimates determined in Somerset County were based on the updated general building stock database in HAZUS.

A specific area that is vulnerable to the severe winter storm hazard is the floodplain. At risk general building stock and infrastructure in floodplains are presented in the flood hazard profile (Section 5.4.3). Generally, losses from flooding associated with severe winter storms should be less than that associated with a 100-year or 500-year flood. In summary, snow and ice melt can cause both riverine and urban flooding. Additionally, cold winter temperatures cause rivers to freeze. A rise in the water level due to snow/ice melt or a thaw breaking the river ice/compacted snow into large pieces can become jammed at man-made and natural obstructions (a.k.a. ice jams). Ice jams can act as a dam, resulting in severe flash riverine flooding.

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. 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.

On average, Somerset County spends approximately $1 million per year on snow removal (including materials and labor). There are 565 lane miles of County roads in Somerset County. On average, the County spends $1,632 per lane mile on snow removal. County roads only account for 10% of the total roadways within Somerset County; therefore, total snow removal costs for the entire County may be approximately $10 Million per year for an average year. According to the County road and bridge department, the cost of clearing municipal roads will likely be lower and the cost of cleaning highways will be higher. Tables 5.4.2-6 and 5.4.2-7 summarize Somerset County's snow removal costs (Slutsky, 2007).

Table 5.4.2-6. Somerset County Snow Removal Costs from 1999 to 2007

Year	Vehicle Cost	Labor Cost	Material Cost	Total cost
1999	$129,280	$91,543	$146,367	$367,190
2000	$277,710	$239,009	$237,037	$753,756
2001	$290,970	$302,657	$183,631	$777,258
2002	$229,442	$234,634	$169,058	$633,134
2003	$498,585	$492,715	$349,075	$1,340,375
2004	$418,302	$371,855	$291,958	$1,082,115
2005	$585,695	$525,631	$319,230	$1,430,556
2006	$250,606	$253,982	$219,444	$724,032
2007	$431,369	$366,024	$393,047	$1,190,440
2008	$454,885	355,144	490,566	$1,300,595
2009	$815,998	$548,463	$977,004	$2,341,465
2010	$724,901	$477,002	$841,776	$2,043,679
2011	$163,329	$129,237*	$145,312	$437,878
2012	$485,725	$339,298	$477,332	$1,302,355
			Minimum total	$367,190
			Maximum total	$2,341,465
			Average	$1,123,202

Source: Slutsky, 2007; Casey, 2013
Note: The snow removal costs are for the year indicated and the following year's winter season. For example, the 2008 removal costs are the costs reported in the 2008 to 2009 Storm Report as provided by the County. Labor costs are the total of the regular and the overtime hours. *Only over-time hours were reported in the 2011 to 2012 Storm Report.

Table 5.4.2-7. Somerset County Snow Removal Costs Per Lane Mile from 1999 to 2007

Year	Vehicle Cost	Labor Cost	Material Cost	Total Cost Per Lane Mile

Year	Vehicle Cost	Labor Cost	Material Cost	Total Cost Per Lane Mile
1999	$229	$162	$259	$650
2000	$492	$423	$420	$1,334
2001	$515	$536	$325	$1,376
2002	$406	$415	$299	$1,121
2003	$882	$872	$618	$2,372
2004	$740	$658	$517	$1,915
2005	$1,037	$930	$565	$2,532
2006	$444	$450	$388	$1,281
2007	$763	$648	$696	$2,107
			Minimum total per lane mile	$650
			Maximum total per lane mile	$2,532
			Average per lane mile	$1,632

Source: Slutsky, 2007
Notes: Somerset County maintains 565 lane miles

Future Growth and Development

As discussed in Sections 4 and 9, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps (subsection I) included in the jurisdictional annexes in Section 9 of this plan.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of 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 (U.S. Environmental Protection Agency [EPA], 2006).

Climate change is beginning to affect both people and resources in the state of New Jersey, and these impacts are projected to continue growing. Impacts related to increasing temperatures are already being felt in the State.

Several agencies, organizations, and academic institutions have addressed the potential effects of climate change on New Jersey. The Union of Concerned Scientists prepared an overview of how climate change may affect New Jersey including the state's coastal area. Among other findings, the report states that the Northeast region is projected to see an increase in winter precipitation on the order of 20 to 30 percent (NJOEM, 2011).

Researchers at Cornell University reported that total precipitation amounts have slightly increased in the Northeast U.S. by approximately 3.3 inches over the last 100 years. There has also been an increase in the number of two-inch rainfall events over a 48-hour period since the 1950s (a 67-percent increase). The historic trends and forecasted changing conditions towards more rainfall will heightens the danger of localized flash flooding, streambank erosion and storm damage (DeGaetano et al [Cornell University], 2010).

Change of Vulnerability

When comparing the 2014 HMP vulnerability assessment to this update, there is a slight decrease in estimated potential losses from severe winter storms. The difference stems from the building inventory used to estimate these losses as well as the decrease in wind speeds between HAZUS-MH 2.1 and HAZUS-MH 4.0. The 2014 HMP used a building inventory consisting of the full Census block shapefile from HAZUS-MH 2.1 (Census 2000) updated with local parcel data using the 2007 building footprints and 2012 parcel spatial files provided by the Somerset County Geographic Information Systems, and replacement cost values that were estimated using 2012 RSMeans values. This process had overestimated exposure and, in turn, the losses that were estimated in the last version of the plan in 2014. This latest plan update was improved by using HAZUS-MH 4.0, where the newer and more accurate 2010 U.S. Census dasymetric block-level data, was used to estimate hazard exposure at the municipal level and replacement cost values were estimated using more recent 2014 RSMeans values. While these improvements to the building inventory resulted in a decrease in structure exposure estimates, the County's vulnerability has not changed since the last version of the plan and the entire County will continue to be exposed and vulnerable to severe winter storm events.

Additional Data and Next Steps

The assessment above identifies vulnerable populations and economic losses associated with this hazard of concern. Historic data on structural losses to general building stock are not adequate to predict specific losses to this inventory; therefore, the percent of damage assumption methodology was applied. This methodology is based on FEMA's How to Series (FEMA 386-2), Understanding Your Risks, Identifying and Estimating Losses (FEMA, 2001) and FEMA's Using HAZUS-MH for Risk Assessment (FEMA 433) (FEMA, 2004). The collection of additional/actual valuation data for general building stock and critical infrastructure losses would further support future estimates of potential exposure and damage for the general building stock inventory. Mitigation strategies addressing early warning, dissemination of hazard information, provisions for snow removal and back-up power are included in Section 9 of this plan.