5.4.8 Severe Winter Storm

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the severe winter storm hazard in Onondaga County.

5.4.8.1 Profile

Hazard Description

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

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

Some winter storms are large enough to immobilize an entire region while others might only affect a single community. Winter storms typically are accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and blocked roadways, downed utility lines, and power outages. In Onondaga County, winter storms include blizzards, snow storms, sleet, freezing rain, and ice storms. Extreme cold temperatures and wind chills are associated with winter storms.

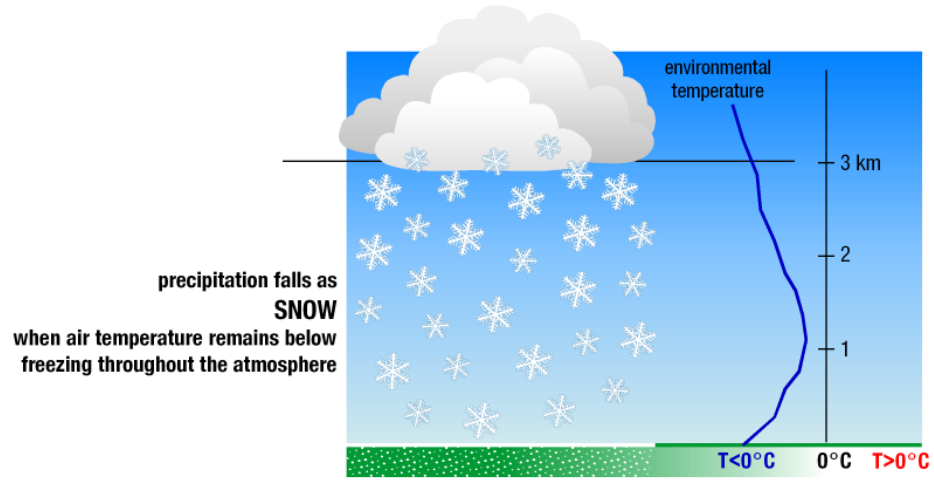
Blizzards

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).

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 °F) and water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or a snow pellet, which then falls to the earth. Snow falls in different forms: snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Figure 5.4.8-1 depicts snow creation.

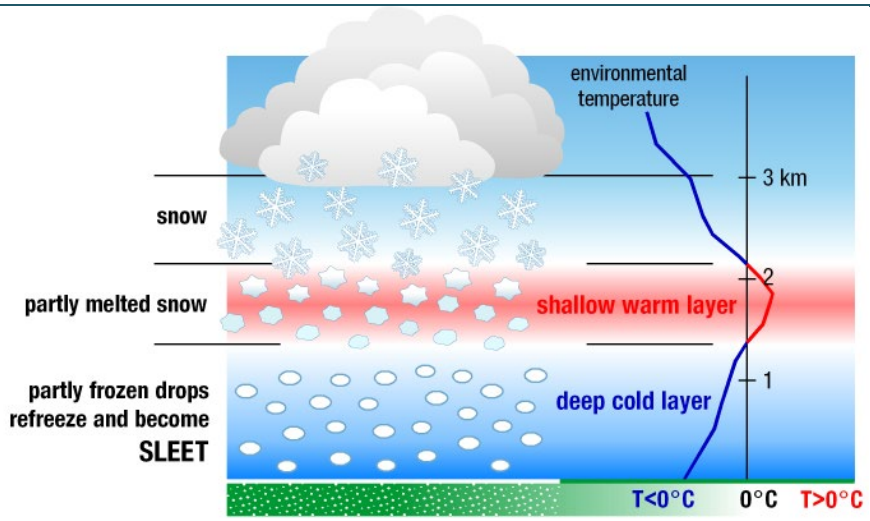
Figure 5.4.8-1. Snow Creation



Source: NOAA-NSSL, 2015

Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets, which are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. Sleet is made up of drops of rain that freeze into ice as they fall through colder air layers. They are usually smaller than 0.30 inches in diameter (NSIDC 2013). Figure 5.4.8-2 depicts sleet creation.

Figure 5.4.8-2. Sleet Creation

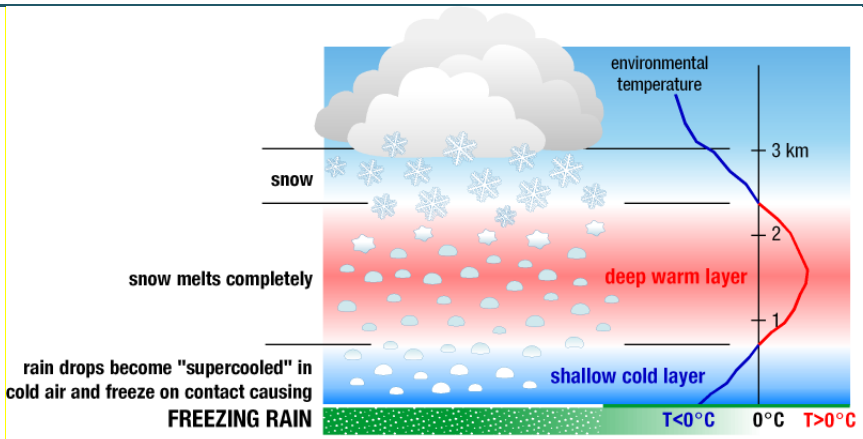


Source: NOAA-NSSL 2015

Ice Storms

An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations typically are accumulations of 0.25-inches or greater (NWS 2013). Heavy accumulations of ice can bring down trees, power lines, utility poles, and communication towers. Ice can disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians (NWS 2008).

Figure 5.4.8-3. Freezing Rain Creation



Source: NOAA-NSSL 2015

Location

All of Onondaga County is susceptible to and experiences winter storms each year. The City of Syracuse is typically in the top ten cities in the country in annual snowfall. According to Figure 5.4.8-4, which provides snowfall statistics for several New York State cities, the normal season average of snowfall for the City of Syracuse is 123.8 inches (Syracuse.com 2019).

Figure 5.4.8-4. Average Snowfall Totals for New York State Cities

Cities	2018 - 2019 Snow Season	Normal avg. to date	This time last year	Normal seasons avg.	Seasonal Snowfall Record
Buffalo	97.5	70.0	83.1	94.7	199.4 inches (1976 - 1977)
Syracuse	80.9	88.9	105.4	123.8	192.1 inches (1992 - 1993)
Rochester	68.0	67.5	85.2	99.5	161.7 inches (1959 - 1960)
Binghamton	64.6	54.7	41.6	83.4	135.2 inches (2016 - 2017)
Albany	37.9	40.7	33.2	60.2	112.5 inches (1970 - 1971)

Source: Syracuse.com 2019

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 and week (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. The National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5 and is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA 2015). Table 5.4.8-1 presents the five RSI ranking categories.

Table 5.4.8-1. RSI Ranking Categories

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

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

Source: NOAA 2015
Note: RSI = Regional Snowfall Index

NWS operates a widespread network of observation systems, such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into future weather, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013).

According to NWS (2018), the magnitude of a severe winter storm can be qualified into five main categories by event type:

- Heavy Snowstorm – Accumulations of 4 inches or more of snow in a 6 hour period, or 6 inches of snow in a 12-hour period.
- Sleet Storm – Significant accumulations of solid pellets that form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists.
- Ice Storm – Significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations.
- Blizzard – Wind velocity of 35 mph or more, temperatures below freezing, considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period.
- Severe Blizzard – Wind velocity of 45 mph, temperatures of 10 °F or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period.

The NWS Forecast Office Binghamton, which serves Onondaga County, uses winter weather watches, warnings, and advisories to help people anticipate what to expect in the days and hours prior to an approaching storm.

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

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with severe winter storm events in Onondaga County. According to the NOAA-NCEI Storm Events Database, Onondaga County experienced 102 winter weather events between 1996 and 2018, including 71 heavy snow events, seven ice storms, 22 winter storms, and two winter weather events. The table below shows these statistics (NOAA NCEI 2018).

Table 5.4.8-2. Severe Winter Events 1996-2018

Hazard Type	Number of Occurrences Between 1950 and 2018	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Blizzard	0	0	0	$0	$0
Extreme Cold/Wind Chill	1	0	0	$0	$0
Heavy Snow	71	1	1	$618K	$0
Ice Storm	7	0	0	$7M	$0
Sleet	0	0	0	$0	$0
Winter Storm	22	0	0	$0	$0
Winter Weather	2	0	0	$0	$0
TOTAL	**102**	**1**	**1**	**$7.618M**	**$0**

Source: *NOAA-NCEI 2018*
Note: *The NOAA-NCEI database reports severe winter storm events from 1996 to present; therefore, the information presented does not include events that occurred before 1996.*

Between 1954 and October 2018, FEMA included New York State in 25 winter storm-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe winter storm, snowstorm, snow, ice storm, winter storm, blizzard, and flooding. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Onondaga County was included in two of these declarations.

Table 5.4.8-3. FEMA Major Disasters and Emergency Declarations in Onondaga County

FEMA Declaration Number	Date(s) Of Event	Declaration Date	Event Type	Details
EM-3107	April 13–17, 1993	March 17, 1993	Snow	Severe Blizzard
DR-1467	April 3-5, 2003	May 12, 2003	Severe Ice Storm	Ice Storm

Source: *FEMA 2018*

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2018, Onondaga County was included in two USDA declarations related to severe winter weather, both involving cold.

- S3249 - March 2012 – Frosts and freezes
- S3594 – May 2013 – Freeze and frost

Table 5.4.8-4 identifies known severe winter storm events that impacted Onondaga County between 2011 and 2018. Appendix E (Supplementary Data) provides information on events that occurred prior to 2011. For detailed information on damages and impacts to each municipality, refer to Section 9 (Jurisdictional Annexes).

Table 5.4.8-4. Severe Winter Weather Events in Onondaga County, 2011 to 2018

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
January 16, 2011	Lake Effect Snow	N/A	N/A	Persistent northwest flow accompanied by a trough of low pressure brought significant lake effect snow to upstate New York. Three hour snowfall amounts of nearly 7 inches were

Table 5.4.8-4. Severe Winter Weather Events in Onondaga County, 2011 to 2018

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
				recorded in Cazenovia during this storm. Snowfall totals ranged from 7.7 inches in Clay in Onondaga County to 10.5 inches at Point Rock in northern Oneida County. Snowfall totals of 7 to 10 inches were common across northern Onondaga, northern Madison, and central and northern Oneida.
February 25, 2011	Winter Storm	N/A	N/A	A low pressure system moved east from the Ohio Valley through southern Pennsylvania on the morning of February 25th. Cold air to the north of the system brought widespread snow to central New York and portions of northeast Pennsylvania throughout the day. Snowfall totals across the county ranged from 5 to 9 inches.
March 6-7, 2011	Heavy Snow	N/A	N/A	A stalled frontal boundary draped along the east coast allowed for a strong surface low pressure system to develop during the daytime hours on Sunday, March 6th. Cold air moved into the area throughout the morning hours on Sunday, changing rain and freezing rain to all snow across portions of central New York. A band of heavy snow developed during the evening hours of March 6th and remained over central New York and northeast Pennsylvania into the morning of March 7th. Snowfall totals from this storm ranged from 1 to 2 feet with several locations in Chenango and Madison counties receiving over 2 feet. Snowfall totals across the county ranged generally from 8 to 21 inches.
January 1, 2012	Heavy Snow	N/A	N/A	A very cold arctic air mass spread over the relatively warm Lake Ontario, causing 5 to 9 inches of lake effect snow in northern Onondaga County. The snow started on the evening of January 2nd and lasted into the morning of January 3rd before diminishing. The heavier snow was focused on northern Oneida County. Higher amounts included 8.4 inches measured by the public 1 mile east-northeast of Cicero, and 9.3 inches measured by a trained spotter 1 mile south-southwest of Sandy Bay.
January 13, 2012	Heavy Snow	N/A	N/A	On January 13, low pressure tracked across northern Lake Ontario, dragging a strong cold front across the area. The cold air changed rain into snow early in the day, then enhancement of the snow from Lake Ontario and Lake Erie caused further snow accumulation for several counties of Central New York in the afternoon, lasting into the predawn hours of January 14. Snow accumulated 7 to 13 inches in Onondaga County. This includes 13.3 inches 3 miles northeast of the Village of Baldwinsville, 13.2 inches at the Village of Liverpool, and 10.4 inches 3 miles east-southeast of Village Green.
December 22, 2012	Lake Effect Snow	N/A	N/A	Low pressure tracked from eastern Michigan on Friday the 21st to southern Quebec on Saturday the 22nd. A cold northwest flow behind this system generated lake effect snow for a large part of central New York. Snowfall amounts ranged from 7 to 14 inches.
December 26-27, 2012	Winter Storm	N/A	N/A	A low pressure system tracked from the Tennessee Valley on Wednesday to just off of the New Jersey coast on Thursday to the Canadian Maritimes on Friday. Northwest flow pulled cold and moist air behind the system with a widespread snow falling across central New York on Wednesday and Thursday. Snowfall amounts across the county ranged from 10 to 13 inches. The highest snowfall total of 13 inches occurred 1 mile west of the Town of Camillus

Table 5.4.8-4. Severe Winter Weather Events in Onondaga County, 2011 to 2018

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
January 20, 2013	Lake Effect Snow	N/A	N/A	A cold front swept from north to south on Sunday, leading to cold northwest flow over the Great Lakes. This generated lake effect snow for central New York. Snowfall amounts ranged from 7 to 13 inches for cities along and north of the New York Thruway. The highest snowfall total of 13 inches occurred 2 miles east-southeast of Brewerton.
February 1-2, 2013	Lake Effect Snow	N/A	N/A	Lake effect snow produced 7 to 10 inches. The highest snowfall total of 10.1 inches occurred 4 miles northeast of the Village of Baldwinsville.
February 4, 2013	Lake Effect Snow	N/A	N/A	A cold northwesterly flow over Lake Ontario produced heavy lake effect snow over portions of central New York. A snow accumulation of 7.5 inches was measured 4 miles west-northwest of the Town of Clay, NY.
February 8, 2013	Heavy Snow	N/A	N/A	A northern system passed over the region while merging with a coastal storm, yielding a period heavy snowfall across the region late February 8 into early February 9, 2013. A period of heavy snow resulted in 6 to 11 inches of snow accumulation. Highest amounts were 11.2 inches in Tully, and 10.5 inches in the Village of East Syracuse.
February 20-21, 2013	Lake Effect Snow	N/A	N/A	A cold westerly flow produced significant lake effect snowfall in portions of central New York. Lake effect snow produced 7 to 10 inches. The highest accumulation of 10 inches fell in Brewerton.
April 1, 2013	Lake Effect Snow	N/A	N/A	A cold northwesterly flow produced significant lake effect snowfall in northern Onondaga and northern Madison counties in central New York. Lake effect snow produced 11.3 inches at the Syracuse Airport.
November 23, 2013	Lake Effect Snow	N/A	N/A	An arctic cold front moved through central New York Saturday afternoon, November 23rd. This front brought a very cold northwest flow of air to central New York. This led to significant lake effect snows across portions of central New York through the afternoon hours of November 24th. Snowfall amount of 10 inches was reported in the Town of Skaneateles.
January 1-3, 2014	Winter Storm	N/A	N/A	A stalled frontal boundary across central New York resulted in light to moderate snowfall across central New York falling during the afternoon hours of Wednesday, January 1st. This snow intensified during the overnight and early morning hours of Thursday, January 2nd as a low pressure system tracked through the Ohio Valley and re-developed off of the eastern seaboard. Snowfall amounts ranged from 8-11 inches across the county. Windy conditions resulted in significant blowing snow and cold temperatures.
February 5, 2014	Winter Storm	N/A	N/A	A low pressure system tracked through the Ohio Valley and re-developed off of the eastern seaboard during the morning hours of Wednesday, February 5th. An intense snow band that developed produced as much as one to three inches of snow per hour during the early morning hours. Snowfall amounts ranged from 7-12 inches across the county. The highest amount of 12 inches fell in the City of Syracuse
February 13, 2014	Winter Storm	N/A	N/A	A low pressure system tracked out of the Gulf of Mexico and along the eastern seaboard on Thursday, February 13th bringing snowfall to the region. Snowfall amounts ranged from 7-10 inches across the county. The highest amount of 9.6 inches fell in South Onondaga.

Table 5.4.8-4. Severe Winter Weather Events in Onondaga County, 2011 to 2018

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
March 12-13, 2014	Winter Storm	N/A	N/A	A low pressure system moved from the central Plains into the Ohio Valley on Wednesday, March 12th. Moisture accompanied this system across the central part of New York with a very tight rain-snow line. Heavy snow fell from the eastern Finger Lakes region northeastward into the Mohawk Valley. Snowfall amounts ranged from 8-17 inches across the county. The highest amount of 16.5 inches fell in the Town of Elbridge.
December 9-11, 2014	Winter Storm	N/A	N/A	A strong low pressure system developed over the eastern seaboard late Monday night, December 8th. This spread precipitation into areas east of the Interstate 81 corridor during the day and evening hours on Tuesday, bringing rain to valley locations and snow to the highest elevations. While accumulations of snow were relatively minor on Tuesday, subsequent upper level waves brought moderate to heavy snow to areas in central New York Wednesday morning into the afternoon hours. Snowfall amounts ranged from 11-28 inches across the county. The highest amount of 27.5 inches fell in Jamesville.
January 5, 2015	Lake Effect Snow	N/A	N/A	A strong cold front ushered in a very cold air across the Great Lakes. This resulted in significant lake effect snow north of the New York Thruway in extreme northern Onondaga county as well as central and northern Oneida county. Snowfall amounts ranged up to 21 inches across the county. There was an extremely sharp gradient from south to north just north of the New York Thruway. The highest amounts of 21 inches fell in Brewerton.
February 1, 2015	Heavy Snow	N/A	N/A	A winter storm tracked from the central Plains on Sunday February 1st to the upper Ohio Valley and western Pennsylvania by Monday morning the 2nd. The storm then moved east off the New Jersey coast and out to sea by Monday evening. This storm spread snow to central New York during the evening hours of the 1st. The snow lasted through the overnight and tapered to snow showers by Monday afternoon. Snowfall of 6 to 10 inches occurred with this winter storm.
February 8, 2015	Heavy Snow	N/A	N/A	A frontal system stalled from northern New England and northern New York southwest to southern Missouri Sunday February 8th. Low pressure tracked along this front Sunday night and Monday morning the 9th as it moved south of the region. The low reached the Middle Atlantic States by Monday afternoon and eventually moved to the southeast away from central New York. This low and frontal system brought a widespread snow to north central New York state beginning Sunday afternoon the 8th and ending by Monday evening the 9th. Snowfall accumulations ranged from 7 to 12 inches.
February 14, 2015	Heavy Snow	N/A	N/A	Low pressure tracked southeast from the Upper Great Lakes region on the evening of Friday the 13th across western New York and Pennsylvania by the evening of the 14th. The low then tracked east on the 14th becoming a major winter storm off the northeast U.S. coast by Sunday the 15th. This low brought more snow to central New York beginning early on Saturday the 14th and lasting until the morning of the 15th. Snow accumulations ranged from 6 to 10 inches.
January 13, 2016	Lake Effect Snow	N/A	N/A	Lake-effect snowfall ranged from 8 to 15 inches in the far northern portion of Onondaga County. The heaviest lake-

Table 5.4.8-4. Severe Winter Weather Events in Onondaga County, 2011 to 2018

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
				effect snowfall amount reported was from the Town of Clay where 15.0 inches of snow fell.
January 17-19, 2016	Lake Effect Snow	N/A	N/A	Lake-effect snowfall ranged from 8 to 21 inches in the northern portion of Onondaga County, especially in the Greater Syracuse area. The heaviest lake-effect snowfall amount reported was from 1 mile east of Split Rock where 21.4 inches of snow fell.
November 19-22, 2016	Lake Effect Snow	N/A	N/A	A strong cold front crossed central New York on Saturday afternoon the 19th. Much colder air followed this front and was accompanied by several inches of snow, especially over the higher terrain. A slow-moving upper air low, which followed this front, slowly tracked across New York into northern New England from Sunday the 20th to Tuesday the 22nd. A northwest flow of cold moist air around this upper level low combined with moisture from the Great Lakes leading to a prolonged period of heavy lake effect snow. Snowfall totals ranged from 20 to 30 inches in most of the county with close to 3 feet in the far east.
December 15, 2016	Lake Effect Snow	N/A	N/A	Lake effect snow amounts ranged between 6 and 9 inches with the highest amount reported in Fairmount of 9 inches.
February 12, 2017	Heavy Snow	N/A	N/A	A winter storm tracked from the Ohio Valley across Pennsylvania to off the southern New England coast from the early morning hours of the 12th to the 13th. The storm brought heavy snow to portions of central and north central New York on the 12th with lake effect snow in its wake until the afternoon of the 13th. Snowfall accumulations ranged from 7 to 14 inches with the highest amount near Oneida.
February 19, 2017	Lake Effect Snow	N/A	N/A	A northwest flow of cold air behind a departing low pressure system brought heavy lake effect snow to portions of north central New York from the late evening of the 9th to the morning of the 10th. Snowfall accumulations ranged from 6 to 11 inches with the highest amount in the Town of Elbridge.
March 14, 2017	Heavy Snow	DR-4322	No	A major winter storm developed over eastern North Carolina during the early morning hours of March 14th. The winter storm tracked northeast during the day on the 14th reaching the Gulf of Maine by the late evening of the 14th. This storm spread a heavy record breaking snowstorm to a large part of central New York and northeast Pennsylvania with blizzard conditions from the Catskills in New York to the Poconos of northeast Pennsylvania and in the greater Scranton Wilkes-Barre area. The snow spread from south to north across northeast Pennsylvania and central New York between midnight and 6 am on the 14th. The snow quickly became very heavy especially east of Rome, New York to Towanda, Pennsylvania Line. Snowfall rates reached up to 5 inches per hour. The heavy snow continued through the day on the 14th and tapered off by late evening in most of northeast Pennsylvania but continued through the 15th as moisture from Lake Ontario combined with northwest winds behind the storm to prolong snowfall for central New York and the far northern tier of eastern Pennsylvania. Many municipalities, and counties declared states of emergency q and/or travel bans. New York state also declared a state of emergency. Snowfall ranged between 20 and 30 inches in Onondaga County.

Table 5.4.8-4. Severe Winter Weather Events in Onondaga County, 2011 to 2018

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
November 19-20, 2017	Lake Effect Snow	N/A	N/A	A low pressure system tracked down the Saint Lawrence River Valley from the 19th to the 20th. A northwest flow of cold air across the relatively warm waters of Lake Ontario led to the first significant lake effect snowstorm for parts of north central New York. Between 6 and 10 inches of snow fell from the evening of the 19th to the morning of the 20th in the far northern part of the County.
December 12, 2017	Heavy Snow	N/A	N/A	Low pressure tracked from the Midwest and Great Lakes from the evening of the 11th to off the New England coast by the evening of the 12th. This low intensified into a major winter storm on the 13th over the Maritime's of Canada. This low brought heavy snow to portions of north central NY from the late evening of the 11th to the evening of the 12th. Then, northwest winds behind the storm brought additional lake effect snow until the evening of the 13th. Snowfall ranged from 7 to 14 inches in Onondaga County.
January 12-13, 2018	Heavy Snow	N/A	N/A	A storm brought widespread snowfall to much of central New York State, with totals of up to 13 inches in some parts. In Onondaga County, snowfall totals ranged from six to 11 inches.
February 7, 2018	Heavy Snow	N/A	N/A	Heavy snow fell over a large part of central New York State, with snowfall totals ranging from five to 12 inches over many locations. In Onondaga County, snowfall totals ranged from five to nine inches.
March 2, 2018	Heavy Snow	N/A	N/A	An intense winter storm brought rain during the evening of March 1st and changed to snow on March 2nd. Strong winds and heavy snow impacted much of central New York State, leading to blizzard conditions. In Onondaga County, snowfall totals ranged from 13 inches to 25 inches. The strong winds caused considerable blowing and drifting snow.

Sources: *FEMA 2018; NOAA-NCEI 2018; SPC 2018*
* *Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*
DR *Major Disaster Declaration (FEMA)*
FEMA *Federal Emergency Management Agency*
Mph *Miles per Hour*
NCEI *National Centers for Environmental Information*
NOAA *National Oceanic and Atmospheric Administration*
N/A *Not Applicable*

Climate Change Projections

In the Tug Hill Plateau region, it is estimated that temperatures will increase by 4.4ºF to 6.4ºF by the 2050s and 5.9ºF to 10.0ºF by the 2080s (baseline of 45.4ºF, mid-range projection). Precipitation totals will increase between 4 and 10% by the 2050s and 6 to 12% by the 2080s (baseline of 42.6 inches, mid-range projection). By the end of the century, the greatest increases in precipitation are projected to be in the northern parts of the state. Although seasonal projections are less certain than annual results, this additional precipitation will most likely occur during the winter months. However, with temperatures rising, some of the increased winter precipitation may fall as rain as opposed to snow.

New York State is already experiencing the effects of climate change during the winter season. Annual ice cover has decreased 71 percent on the Great Lakes since 1973. This decrease may lead to increased lake-effect snow in Onondaga County in the next two decades through greater moisture availability. By mid-century, however,

lake-effect snow will generally decrease as temperatures below freezing become less frequent (NYSERDA 2014).

Probability of Future Occurrences

Table 5.4.8-5 summarizes data regarding the probability of occurrences of severe winter storm events in Onondaga County based on the historic record. Heavy snow events are the most common in Onondaga County, followed by winter storms. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 5.4.8-5. Probability of Future Occurrence of Severe Winter Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Blizzard	0	0	0	0	0%
Extreme Cold/Wind Chill	15	0.22	4.6	0.22	21.7%
Heavy Snow	71	1.04	0.97	1.03	100%
Ice Storm	7	0.10	9.86	0.10	10.14%
Sleet	0	0	0	0	0%
Winter Storm	22	0.32	3.14	0.32	31.88%
Winter Weather	2	0.03	34.50	0.03	2.90%
Total	**103**	**1.51**	**0.67**	**1.49**	**100%**

Source: NOAA-NCEI 2018

Based on historical data from NYSERDA (2011), it is expected that the following will occur at least once per 100 years:

- Up to four inches of freezing rain in the ice band near central New York State of which between 1–2 inches of accumulated ice will occur over a 24-hour period.
- Up to two feet of accumulated snow in the snow band in northern and western New York State over a 48-hour period.

In Section 5.3, the identified hazards of concern for Onondaga County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for severe winter storms in the County is considered 'frequent' (event has a 100% annual probability and may occur multiple times per year).

5.4.8.2 Vulnerability Assessment

All of Onondaga County is exposed to the severe winter storm hazard; therefore, all assets in the county (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 4), are potentially vulnerable to a severe winter storm event. The following summarizes the estimated potential impacts of severe winter storm events on the county.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population of Onondaga County (468,050 people) is exposed to severe winter storm events (US Census Bureau 2016). 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 and/or hypothermia from attempts to clear snow and ice.

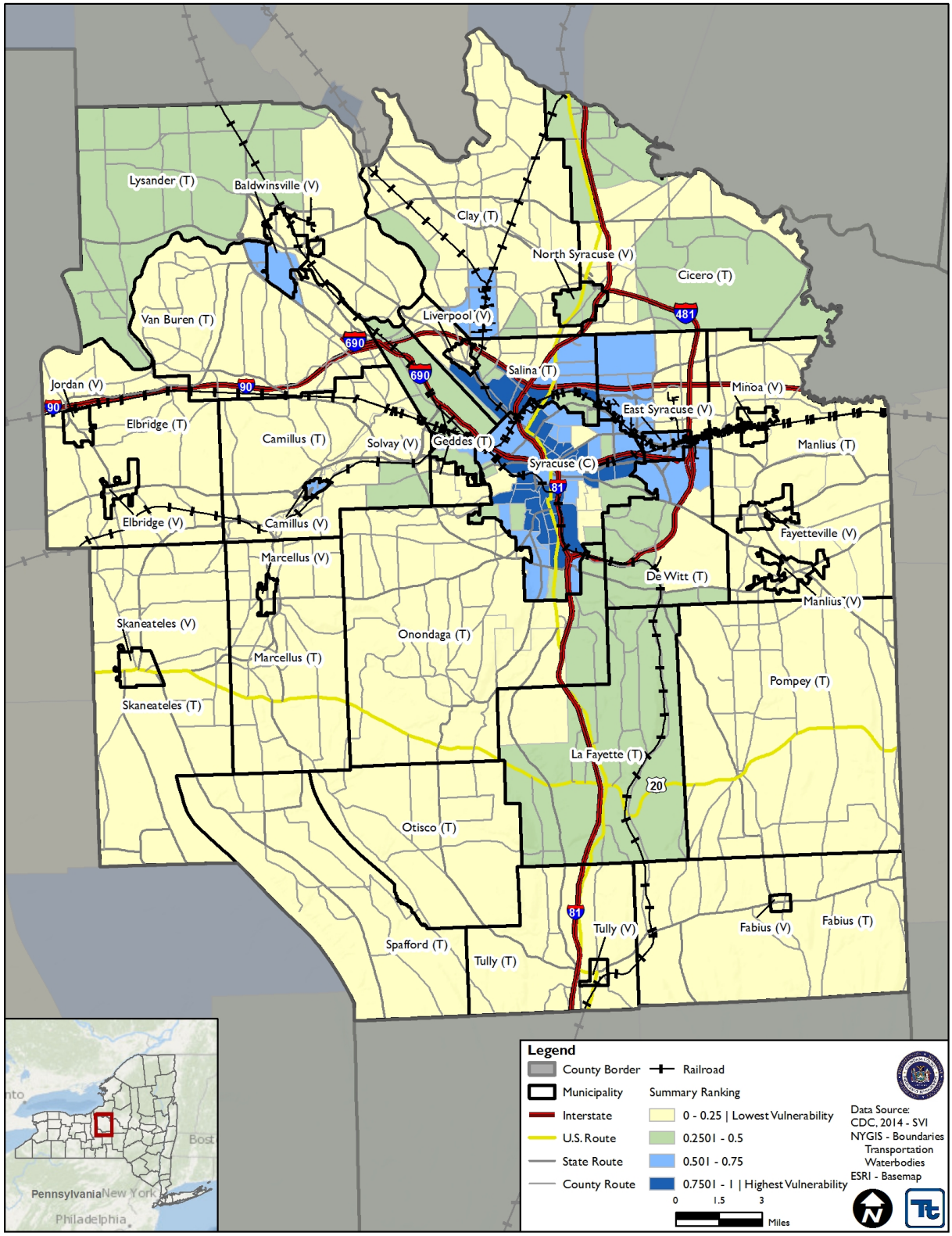
According to the 2016 ACS 5-Year Population Estimate, 15.3 percent of the population in Onondaga County is 65 and over. In addition, severe winter storm events can reduce the ability of these populations to access emergency services. In Onondaga County, the following areas have the highest concentration of elderly population: City of Syracuse and Villages of Baldwinsville, East Syracuse, Fayetteville, Liverpool, Minoa, and North Syracuse; locations of higher concentrations are also present in areas throughout each of the county's towns. Refer to Figure 4-9 in Section 4 (County Profile) that displays the densities of populations over 65 in Onondaga County.

The homeless and 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). Refer to Figure 4-11 in Section 4 (County Profile) that displays the densities of low-income populations in Onondaga County. Additionally, homeless populations may not have access to housing or sheltering during a severe winter storm.

According to the Center for Disease Control and Prevention's (CDC) 2014 Social Vulnerability Index, Census Tracts 2, 5.01, 6, 14, 15, 16 ,17.01, 21.01, 23, 24, 30, 35, 36.01, 36.02, 38, 39, 40, 42, 43.01, 51, 52, 53, 54, 55, 58, 59, 61.01 in the City of Syracuse and Census Tract 137.01 in the Town of Salina are ranked in the highest vulnerability category with values between 0.752 and 0.998; Census Tract 53 in the City of Syracuse has the highest social vulnerability with a ranking of 0.998. The vulnerable population located in these Census Tracts in the City of Syracuse and Town of Salina may be more susceptible to impacts from severe winter storms. Figure 5.4.8-5 below displays the CDC 2014 Social Vulnerability Index for Onondaga County.

Heavy snow can immobilize a region and paralyze a city. Additional impacts include 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 Onondaga County, the towns are generally rural compared to the villages and cities. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NSSL 2006).

Figure 5.4.8-5 CDC's Social Vulnerability Index 2014



Impact on General Building Stock

The entire general building stock inventory in Onondaga County is exposed and potentially vulnerable to the severe winter storm hazard; however, properties in poor condition or in particularly vulnerable locations may be at risk for the most damage. 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 5.4.8-6 summarizes the estimated loss to structures as a result of 1 percent, 5 percent, and 10 percent loss. Given professional knowledge and the currently available information, the potential loss for this hazard is many times considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place, etc.). Therefore, the following information should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 5.4.8-6. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events (Structure Only)

Municipality	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Onondaga County	$71,828,499,104	$718,284,991	$3,591,424,955	$7,182,849,910

Source: Syracuse-Onondaga County Planning Agency, 2018

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 the flood hazard profile (Section 5.4.3). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 100-year flood. In addition, coastal areas are at high risk during winter storm events that involve high winds. Please refer to the severe storm profile (Section 5.4.7) profile for losses resulting from wind.

Impact on Critical Facilities

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

Severe winter storms can indirectly impact critical facilities. Heavy snow and ice loads can bring down trees and utilities that can damage

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 can prevent the commuter population traveling to work within and outside of the county. Depending on the severity of a storm, the State, County, or municipalities can implement travel advisories or restrictions. With these advisories and restrictions in place, businesses and government offices can be closed, resulting in a loss of productivity and economic activity.

The communities in Onondaga County spend significant resources treating the roadways before and after winter events. The City of Syracuse recently implemented a sidewalk clearing program on major roadways to allow for students, workers, and other commuters to safely walk to their destination. Historically, many commuters were forced to walk in the streets while sidewalks remained snow covered.

Future Changes that May Impact Vulnerability

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

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Projected Development

As discussed in Sections 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.

Current New York State land use and building codes incorporate standards that address and mitigate snow accumulation. Some local municipalities in the County have implemented the following activities to eliminate loss of life and property and infrastructure damages during winter storm events:

- Remove snow from roadways and sidewalks.
- Remove dead trees and trim trees/brush from roadways to lessen falling limbs and trees.
- Ensure proper road signs are visible and installed properly.
- Bury electrical and telephone utility lines to minimize downed lines.
- Remove debris/obstructions in waterways and develop routine inspections/maintenance plans to reduce potential flooding.
- Replace substandard roofs of critical facilities to reduce exposure to airborne germs or mold resulting from leakage.
- Purchase and install backup generators in evacuation facilities and critical facilities to essential services to residents.
- Install cell towers in areas where limited telecommunication is available to increase emergency response and cell phone coverage (NYS DHSES, 2014).

Projected Changes in Population

Between 2011 and 2015, the total homeless shelter population in Onondaga County increased by 9.5 percent, while the count of homeless families with children living in homeless shelters increased by 97.8 percent, from 45 families with children in 2011 to 89 families in 2015 (New York Communities for Change, 2016). Additionally, between 2017 and 2018, a Housing and Homeless Commission Point in Time survey in Syracuse found that the count of youth living without a home has nearly tripled (Proia, 2018). The homeless population is vulnerable to extreme weather events inclusive of storms and extreme temperatures, and the county's vulnerability will increase should this trend continue.

According to population projections from the Cornell Program on Applied Demographics, Onondaga County will experience a slight population decrease through 2040 (less than 10,000 people in total by 2040). Population

change is not expected to have a measurable effect on the overall vulnerability of the county's population over time. As discussed in *Long Range Transportation Plan 2050: Moving Towards a Greater Syracuse*, the population of Syracuse has decreased as the other municipalities in the county have seen an increase (Syracuse Metropolitan Transportation Council, 2015). Those moving to from areas of lower vulnerability to higher will increase their vulnerability, though not in a dramatic fashion. However, a closer examination of the age of the population, changes in their geography and how climate change may alter the winter weather received (rain versus snow) will be just as important to continue to assess future changes in vulnerability. Refer to Section 4.6.2 - Population Trends in the County Profile for a discussion on trends for the County.

Climate Change

As discussed earlier, it is uncertain how climate change will influence extreme winter storm events; initially the region may experience an increase in lake-effect snow due to increased moisture availability from decreasing ice cover on the Great Lakes, while by mid-century, the region may see a decrease in snow due to less frequent temperatures below freezing (NYSERDA, 2014). With a potential for more frequent lake-effect snow events over the next two decades, the County's assets will be at risk for the impacts of more frequent severe winter storm events. An increase in the frequency and severity of severe winter storms may result in an increase of snow loads on the County's building stock and infrastructure, putting each building at risk for structural damage. More frequent and severe events will also result in increased resources being spent to prepare for and clean-up after an event. However, as winter temperatures continue to rise, the increase in precipitation is likely to occur during the winter months as rain. Increased rain on snowpack or frozen or saturated soils may lead to increased flooding and related impacts on the County's assets.

Change of Vulnerability

Overall, the entire County remains vulnerable to severe winter storms. The updated vulnerability assessment provides a more current risk assessment and analysis for the County.

Issues Identified

Important issues associated with a severe winter storm in the planning area include the following:

- Older building stock in Onondaga County might be more vulnerable to the aftermath of a winter storm event. Heavy snow loads on the roofs of buildings might not be able to withstand the extra weight.
- Ice and freezing temperatures can lead to frost heaving, damaging roads, bridges, buildings, home foundations, and railroad tracks.
- The impacts of drought and invasive species can lead to dead or dying trees. These trees are more susceptible to falling during winter storm events from the weight of snow and ice, causing power outages, closed roadways, and damage to buildings and property.
- Downed power lines from the weight of snow and ice lead to power outages, leaving many homes without a source of heat.
- Loss of economic activity when travel restricted