5.4.5 Severe Winter Storm

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

5.4.5.1 Profile

This section presents information regarding the description, extent, location, previous occurrences and losses, climate change projections and probability of future occurrences for the severe winter storm hazard.

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:

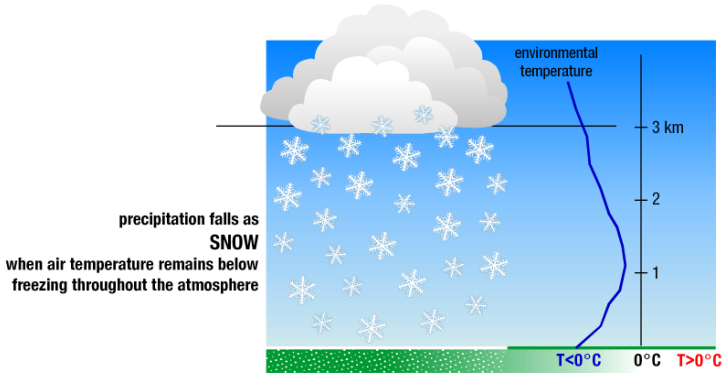
- Below freezing temperatures (cold air) in the clouds and near the ground to make snow and ice.
- Lift, something to raise the moist air to form clouds and cause precipitation, such as warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside (oliographic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

Some winter storms can immobilize an entire region, while others might only affect a single community. Winter storms typically are accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and blocked roadways, downed utility lines, and power outages. Westchester County's winter storms include blizzards, snowstorms, Nor'Easters, and ice storms. Extreme cold temperatures and wind chills are associated with winter storms.

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 5.4.5-1 depicts snow creation.

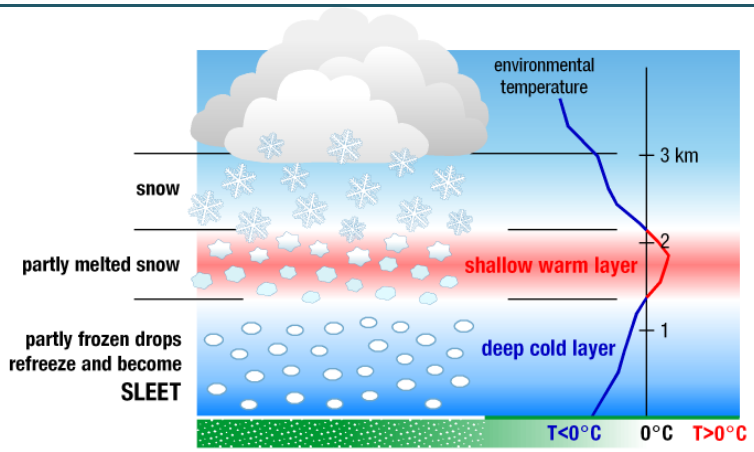
Figure 5.4.5-1. Snow Creation



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 (NSSL 2021)

Figure 5.4.5-2. Sleet Creation



Source: NOAA-NSSL 2020

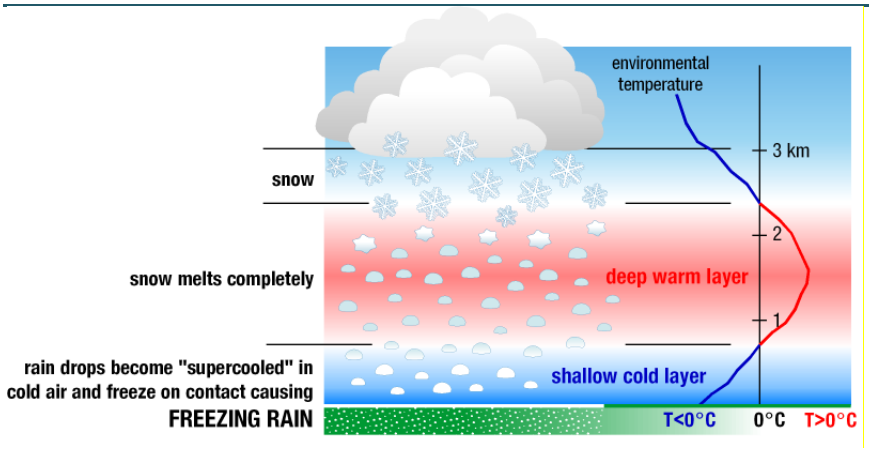
Blizzards

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, as the predominant conditions over a 3-hour period. Extremely cold temperatures often are associated with blizzard conditions but are not a formal part of the definition. The hazard, created by the combination of snow, wind, and low visibility, significantly increases when temperatures are below 20 °F. A severe blizzard is categorized as having temperatures near or below 10 °F, winds exceeding 45 mph, and visibility reduced by snow to near zero. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm, moister air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (Lam 2019).

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 (Dolce 2012).

Figure 5.4.5-3. Freezing Rain Creation



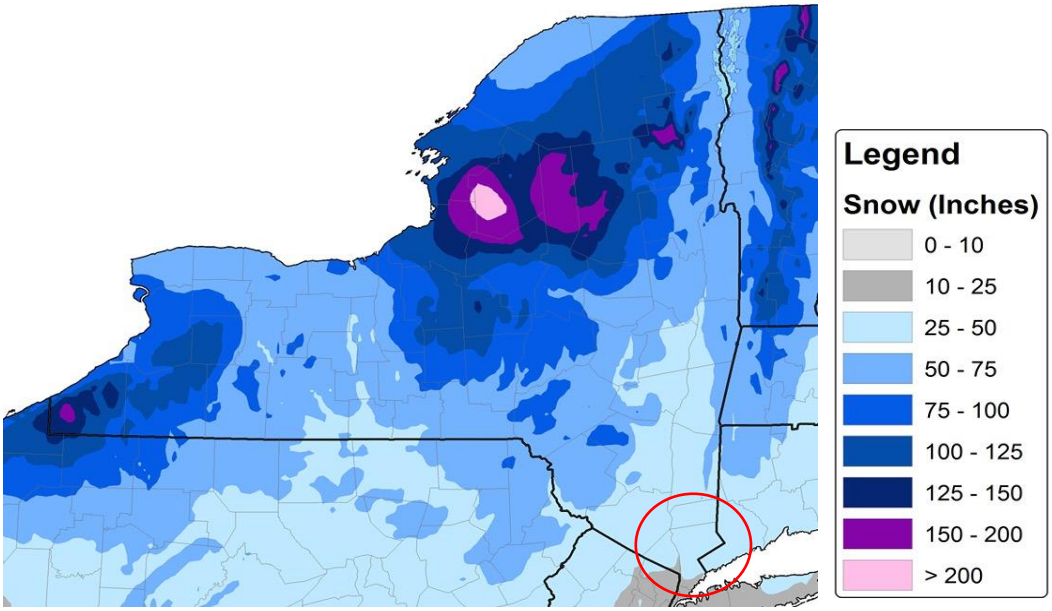
Source: NOAA-NSSL 2020

Location

Snow and Blizzards

Snowfall in New York State is highly variable. The inland regions of the State see an average seasonal amount of 40 inches or more, whereas the coastal regions typically see 25 to 35 inches. More than half of New York State's land area sees more than 70 inches of snow each season (NDC 2016). According to data from Cornell University, snowfall in Westchester averages between 25 and 50 inches a year. In terms of snowfall totals across the state, this is on the lower end of the spectrum. Much of the lower Hudson Valley experiences similar snowfall totals, whereas New York City and Long Island see approximately 10-25 inches/year. Much of the northern and western parts of the State (particularly those in higher elevations and near the lakes) can see at least 75 to 100 inches per year (NYS DHSES 2019).

Figure 5.4.5-4. New York Annual Average Snowfall, 1960-2012



Source: Cornell University, NYSkiBlog.com
Note: The red circle indicates the location of Westchester County.

Ice Storms

The Midwest and Northeast United States are prime areas for freezing rain and ice storm events. These events can occur anytime between November and April, with most events occurring during December and January. Based on data from 1948 to 2000, the average annual number of days with freezing rain for Westchester County is five to six days, and the average annual number of hours is nine to fifteen hours (MRCC 2020).

Extent

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

The extent of a severe winter storm can be classified both by meteorological measurements and by evaluating societal impacts. The National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5 and is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population. The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA 2021) Table 5.4.5-1 presents the five RSI ranking categories.

Table 5.4.5-1. RSI Ranking Categories

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

Source: NOAA 2020
Note: RSI = Regional Snowfall Index

The NWS operates a widespread network of observing systems, such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts. According to NWS (NWS 2021), the magnitude of a severe winter storm can be qualified into five main categories by event type:

Table 5.4.5-2. Winter Storm Category Thresholds

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.

Additionally, the NWS uses winter weather watches, warnings, and advisories to help people anticipate what to expect in the days and hours prior to an approaching storm (NWS 2021). Refer to Figure 5.4.5.1-5 for the warning thresholds.

Figure 5.4.5.1-5. Winter Storm Warning Thresholds

Previous Occurrences and Losses

Based on a review of historic weather events and losses, Westchester County was found to have frequent winter storm occurrences. According to the NOAA-NCEI storm events database, Westchester County has been impacted by 174 winter weather events between 1954 and August 2021, including 7 blizzard events, 85 heavy snow events, 4 ice storms, 49 winter storms, and 29 winter weather events (NOAA 2021).

FEMA Major Disaster and Emergency Declarations

Between 1954 and October 2021, FEMA included New York State in 26 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. Westchester County was included in three of these declarations.

Table 5.4.5-3 FEMA Major Disasters and Emergency Declarations in Westchester County

Disaster Number	Declaration Date	Event Date	Incident Type	Title
EM-3184	March 27, 2003	February 17, 2003 -- February 18, 2003	Snow	Snow
DR-1083	January 12, 1996	January 6, 1996 -- January 12, 1996	Snow	Blizzard of '96 (Severe Snow Storm)
EM-3107	March 17, 1993	March 13, 1993 -- March 17, 1993	Snow	Severe Blizzard

Source: FEMA 2021

DR *Major Disaster Declaration (FEMA)*
EM *Emergency Declaration (FEMA)*
FEMA *Federal Emergency Management Agency*

USDA Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2014 and 2021, Westchester County was included in one USDA declarations involving severe winter weather which was categorized as a frost, freeze, and excessive snow event and occurred between January 1 and May 24, 2015 with USDA designation code S3886.

Previous Events

Table 5.4.5-4 identifies the known severe winter storm events that impacted Westchester County between 2014 and 2021. For events prior to 2015, refer to Appendix E (Supplementary Data). For detailed information on damages and impacts to each municipality, refer to Section 9 (Jurisdictional Annexes).

Table 5.4.5-4. Severe Winter Weather Events in Westchester County, 2014 to August 2021

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
January 2, 2014	Heavy Snow	NA	NA	The public and trained spotters reported widespread snowfall of 6 to 8 inches.
January 21, 2014	Heavy Snow	NA	NA	The public and trained spotters reported widespread snowfall totals of 10 to 13 inches.
February 3, 2014	Heavy Snow	NA	NA	The public and a trained spotter reported widespread 6 to 9 inches snowfall.
February 5, 2014	Heavy Snow	NA	NA	Trained spotters, the public, and an NWS cooperative observer reported widespread 7 to 12 inches snowfall.
February 13, 2014	Winter Storm	NA	NA	Trained spotters and the public reported widespread snowfall of 15 to 16 inches, plus freezing rain accretion of 2 tenths of an inch in Peekskill.
November 26, 2014	Heavy Snow	NA	NA	Snowfall ranged from 3 to 5 inches along and north/west of the heavily traveled Interstate 287 and 684 corridors per a combination of cooperative observer, trained spotter, and public reports.
January 18, 2015	Winter Weather	NA	NA	Freezing rain accumulated 0.1 inch in Somers. The freezing rain led to widespread motor vehicle accidents and injuries, including 5 injuries in a vehicle rollover on the northbound Taconic State Parkway at the Route 202 exit.
January 24, 2015	Heavy Snow	NA	NA	A cooperative observer in Shrub Oak, trained spotters, and the public reported snowfall of 6 to 7 inches.
January 26, 2015	Winter Storm	NA	NA	Trained spotters and the public reported snowfall of 10 to 11 inches. North winds gusted to 43 mph at the Westchester County Airport, with blowing and drifting of snow.
February 1, 2015	Heavy Snow	NA	NA	Snowfall ranged from 6 to 11 inches across the county. The highest amount of 10.7 inches was reported in Armonk, NY.
February 21, 2015	Winter Weather	NA	NA	The public reported snowfall of 6 inches in Cross River, and 5.5 inches in Armonk.
March 1, 2015	Heavy Snow	NA	NA	A trained spotter in Somers and public reports from elsewhere indicated around 6 inches of snowfall.
March 5, 2015	Heavy Snow	NA	NA	Trained spotters and the public measured 6 to 8 inches of snow.
January 17, 2016	Winter Weather	NA	NA	Icy conditions led to a massive 14-car pileup in Yonkers at about 8:45 PM Sunday January 17th, injuring 10 people and closing down a mile-long, southbound stretch of the Bronx River Parkway where the highway merges with the Sprain Brook Parkway for more than 12 hours.
January 23, 2016	Winter Storm	NA	NA	The public and trained spotters reported snowfall of 13 to 25 inches. Also, north winds at Larchmont Harbor were sustained at 38 mph with gusts up to 49 mph between 9 AM and 10 AM on Saturday January 23rd. Southern Westchester likely experienced blizzard conditions during the late morning and early afternoon on Saturday January 23rd, as nearby LaGuardia and Bridgeport ASOS observations showed visibility less than one quarter mile in heavy snow and frequent wind gusts over 35 mph during that time.

Table 5.4.5-4. Severe Winter Weather Events in Westchester County, 2014 to August 2021

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
December 17, 2016	Winter Weather	NA	NA	Trained spotters, the public, and social media reported snowfall of 3.5 to 5 inches.
January 7, 2017	Winter Weather	NA	NA	Trained spotters, the public, and social media reported 4 to 6 inches of snowfall.
February 9, 2017	Winter Storm	NA	NA	Trained spotters, amateur radio, and the public reported 9 to 12 inches of snowfall. Winds gusted to 43 mph at White Plains Airport at 12:46 pm.
March 14, 2017	Winter Storm	NA	NA	Trained spotters, a cooperative observer, and the public reported 11 to 15 inches of snowfall. Some sleet also mixed in with the heavy snow. A 49 mph wind gust was also reported at a WeatherFlow mesonet station in Mamaroneck at 2:17 pm.
January 4, 2018	Blizzard	NA	NA	Westchester County Airport (White Plains, NY) ASOS observations showed blizzard conditions, with visibility less than one quarter mile in heavy snow and frequent wind gusts over 35 mph during the morning and early afternoon on January 4th.
February 17, 2018	Heavy Snow	NA	NA	CoCoRaHS observers, trained spotters, and the public reported 6 to 8 inches of snowfall.
March 7, 2018	Winter Storm	NA	NA	Fire department/rescue reported 13.5 inches of snow in Armonk. 9 to 14 inches was reported across northern Westchester from CoCoRaHS observers, a COOP observer, and the public. The heavy wet snow combined with strong winds to bring down tree limbs and a few power lines.
March 21, 2018	Winter Weather	NA	NA	Trained spotters, social media, and the public reported 2 to 8 inches of snow. These totals were reached in more than 12 hours and did not meet NWS criteria for warning level snow.
April 2, 2018	Heavy Snow	NA	NA	Trained spotters and the public reported 6 to 8 inches of snowfall.
November 15, 2018	Winter Storm	NA	NA	Social Media, trained spotters, CoCoRaHS, and the public reported 6 to 9 inches of snow.
January 19, 2019	Winter Storm	NA	NA	The nearby Danbury, CT ASOS reported 0.37 inches of ice accretion. The broadcast media reported significant impacts due to ice accretion. Power companies were working on many downed trees on power lines in Southeast and in North Salem. A large tree branch came down on Route 121 in North Salem causing the live wires to catch fire. Significant impacts were also observed in nearby northern Fairfield county Connecticut.
March 3, 2019	Heavy Snow	NA	NA	CoCoRaHS and the public reported 6 to 10 inches of snow.
December 1, 2019	Winter Weather	NA	NA	An NWS COOP Observer in Shrub Oak reported 4.5 inches of snow. CoCoRaHS observers, social media, trained spotters, and the public reported 2 to 6 inches of snow.
December 16, 2020	Winter Storm	NA	NA	A CoCoRaHS observer 2 miles east of Yorktown Heights measured 11 inches of snow and a CoCORaHS observer 2 miles south of Peach Lake measured 10.9 inches of snow. Amateur radio and trained spotters measured 10 to 12 inches of snow. Winds gusted to 40 mph at the Westchester County Airport at 6:56 am on December 17, 2020.
February 1, 2021	Winter Storm	NA	Yes	Trained spotters and amateur radio reported 14 to 20 inches of snow. A 46 mph wind gust was recorded by the White Plains Airport ASOS at 4:56 pm February 1, 2021.

Table 5.4.5-4. Severe Winter Weather Events in Westchester County, 2014 to August 2021

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
February 7, 2021	Heavy Snow	NA	Yes	Amateur radio in New Rochelle and White Plains reported 6.5 inches of snow and 6.0 inches of snow respectively. A trained spotter 2 miles south of Yonkers reported 6.1 inches of snow.

Sources: *FEMA 2021; NOAA-NCEI 2021; SPC 2021*
* *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

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to increase. The impacts related to increasing temperatures and sea level rise are already causing complications in the state. *ClimAID: The Integrated Assessment for Effective Climate Change in New York State (ClimAID)* was undertaken to provide decision-makers with information on the state's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (NYSERDA 2011/2014).

Temperatures in New York State are warming, with an average rate of warming over the past century of 0.25° F per decade. Average annual temperatures are projected to increase across New York State by 2–3.4 °F by the 2020s, 4.1–6.8 °F by the 2050s, and 5.3–10.1 °F by the 2080s. By the end of the century, the greatest warming is projected to be in the northern section of the state (NYSERDA 2011/2014).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Westchester County is part of Region 5 (Hudson River and Mohawk River Valleys), where temperatures are estimated to increase by 4.5 to 6.2ºF by the 2050s and 5.6 to 9.7ºF by the 2080s (baseline of 47.6ºF, middle range projection). Precipitation totals are estimated to increase between four to twelve percent by the 2050s and five to fifteen percent by the 2080s (baseline of 38.6 inches, middle range projection). Table 5.4.5-5 displays the projected seasonal precipitation change for the region (NYSERDA 2011/2014).

Table 5.4.5-5. Projected Seasonal Precipitation Change in Region 5, 2050s (% change)

Winter	Spring	Summer	Fall
+5 to +15	-5 to +10	-5 to +5	-5 to +10

Source: NYSERDA 2014

New York State already is experiencing the effects of climate change during the winter season. Winter snow cover is decreasing, and spring comes, on average, about a week earlier than it did a few years ago. Nighttime temperatures are measurably warmer, even during the colder months. Overall winter temperatures in New York State are almost 5 degrees warmer than in 1970 (NYSERDA 2011/2014). The state has experienced a decrease in the number of cold winter days (below 32 °F) and can expect to see a decrease in snow cover by as much as 25–50 percent by end of the next century. The lack of snow cover may jeopardize opportunities for skiing, snowmobiling, and other types of winter recreation; and natural ecosystems will be affected by the changing snow cover (Cornell University College of Agriculture and Life Sciences 2011). As the century progresses, snowfall is likely to become less frequent, with the snow season decreasing in length. It is uncertain if there will be changes in the intensity of snowfall during each storm; however, it is possible that higher temperatures in colder parts of New York State could support higher snowfall totals during snowstorm events (NYSERDA 2011/2014).

Some climatologists believe that climate change could play a role in the frequency and intensity of Nor'Easters. Two ingredients are needed to produce strong Nor'Easters and intense snowfall: (1) temperatures which are just below freezing and (2) massive moisture coming from the Gulf of Mexico. When temperatures are far below freezing, snow is less likely. As temperatures increase in the winter months, they will be closer to freezing rather than frigidly cold. Climate change is expected to produce more moisture, thus increasing the likelihood that these two ingredients (temperatures just below freezing and intense moisture) will cause more intense snow events.

Probability of Future Occurrences

Table 5.4.5-6 summarizes data regarding the probability of occurrences of severe winter storm events in Westchester County based on the historic record. Heavy snow events and winter storms are the first and second

most common in Westchester County, respectively. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 5.4.5-6. Probability of Future Occurrence of Severe Winter Weather Events in Westchester County

Hazard Type	Number of Occurrences Between 1954 and 2021	% Chance of Occurring in Any Given Year
Blizzard	7	10.3%
Heavy Snow	85	100%
Ice Storm	4	5.9%
Winter Storm	49	72%
Winter Weather	29	42.7%
TOTAL	**174**	**100%**

Source: *NOAA-NCEI 2021*
Note: *Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act (Public Law 81-875), and selected winter storm events since 1996. Due to limitations in data, not all winter storm events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated*

Based on historical data from NYSERDA (2014), 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.

Based on geography, location, past event history, and climate projections, Westchester County will continue to experience winter storm events. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings; refer to Section 5.3 (Hazard Ranking) for additional information on the hazard ranking methodology and probability criteria. The probability of occurrence for severe winter storms in the County is considered frequent (event has a 100 percent annual probability and might occur multiple times in the same year).

5.4.5.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the severe winter storm hazard, all of Westchester 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 4), are vulnerable to a winter storm event.

Impact on Life, Health and Safety

The entire population of Westchester County (968,065) is exposed to severe winter storm events (US Census n.d.). According to the NOAA National Severe Storms Laboratory (NSSL); every year, winter weather indirectly and deceptively kills hundreds of people in the U.S., primarily from automobile accidents, overexertion and exposure. Winter storms are often accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, drifting snow and extreme cold temperatures and dangerous wind chill. They are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. People can die in traffic accidents on icy roads, heart attacks while shoveling snow, or of hypothermia from prolonged exposure to cold (NSSL 2021).

The homeless and elderly are considered most susceptible to this hazard. The elderly are considered susceptible to this hazard due to their increased risk of injuries and death from falls and overexertion and/or hypothermia from attempts to clear snow and ice. According to the 2019 American Community Survey 5-Year population estimate, there are 162,363 persons over 65 years old that reside in the County that are considered vulnerable to severe winter weather. In addition, severe winter storm events can reduce the ability of these populations to access emergency services.

Additionally, the homeless and residents below the poverty level may not have access to housing or their housing could be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). Residents with low incomes might not have access to housing or their housing can be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). In Westchester County, the City of Yonkers has the highest concentration of population below the poverty level (14.7% total population). Refer to Section 4 (County Profile) that displays the distribution of low-income populations in Westchester County.

Impact on General Building Stock

The entire general building stock inventory is exposed and vulnerable to the severe winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. As an alternate approach, this plan considers percent damages that could result from severe winter storm conditions. 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 5.4.5-7 below summarizes the estimated loss based on 1-, 5-, and 10-percent losses. 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 5.4.5-7. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Jurisdiction	Total Replacement Cost Value (RCV)	1-Percent Exposure/Loss	5-Percent Exposure/Loss	10-Percent Exposure/Loss
Ardsley (V)	$1,184,178,473	$11,841,785	$59,208,924	$118,417,847
Bedford (T)	$6,187,290,490	$61,872,905	$309,364,525	$618,729,049
Briarcliff Manor (V)	$2,929,350,441	$29,293,504	$146,467,522	$292,935,044
Bronxville (V)	$2,422,176,980	$24,221,770	$121,108,849	$242,217,698
Buchanan (V)	$1,174,838,972	$11,748,390	$58,741,949	$117,483,897
Cortlandt (T)	$7,539,300,494	$75,393,005	$376,965,025	$753,930,049
Croton-on-Hudson (V)	$5,339,173,282	$53,391,733	$266,958,664	$533,917,328
Dobbs Ferry (V)	$3,524,751,416	$35,247,514	$176,237,571	$352,475,142
Eastchester (T)	$4,342,629,796	$43,426,298	$217,131,490	$434,262,980
Elmsford (V)	$2,719,155,604	$27,191,556	$135,957,780	$271,915,560
Greenburgh (T)	$42,009,346,893	$420,093,469	$2,100,467,345	$4,200,934,689
Harrison (T)	$10,415,934,158	$104,159,342	$520,796,708	$1,041,593,416
Hastings-on-Hudson (V)	$13,267,692,589	$132,676,926	$663,384,629	$1,326,769,259

Jurisdiction	Total Replacement Cost Value (RCV)	1-Percent Exposure/Loss	5-Percent Exposure/Loss	10-Percent Exposure/Loss
Irvington (V)	$1,575,655,219	$15,756,552	$78,782,761	$157,565,522
Larchmont (V)	$3,287,198,418	$32,871,984	$164,359,921	$328,719,842
Lewisboro (T)	$5,313,683,830	$53,136,838	$265,684,192	$531,368,383
Mamroneck (T)	$2,363,450,350	$23,634,504	$118,172,518	$236,345,035
Mamaroneck (V)	$7,321,897,360	$73,218,974	$366,094,868	$732,189,736
Mount Kisco (T)	$5,913,464,031	$59,134,640	$295,673,202	$591,346,403
Mount Pleasant (T)	$8,309,807,831	$83,098,078	$415,490,392	$830,980,783
Mount Vernon (C)	$17,021,941,779	$170,219,418	$851,097,089	$1,702,194,178
New Castle (T)	$4,957,954,777	$49,579,548	$247,897,739	$495,795,478
New Rochelle (C)	$42,795,863,468	$427,958,635	$2,139,793,173	$4,279,586,347
North Castle (T)	$5,067,704,057	$50,677,041	$253,385,203	$506,770,406
North Salem (T)	$2,372,126,897	$23,721,269	$118,606,345	$237,212,690
Ossining (T)	$1,382,487,862	$13,824,879	$69,124,393	$138,248,786
Ossining (V)	$6,071,219,565	$60,712,196	$303,560,978	$607,121,957
Peekskill (C)	$6,315,622,346	$63,156,223	$315,781,117	$631,562,235
Pelham (T)*	$3,648,777,424	$36,487,774	$182,438,871	$364,877,742
Pelham (V)	$2,384,243,499	$23,842,435	$119,212,175	$238,424,350
Pelham Manor (V)	$1,264,533,925	$12,645,339	$63,226,696	$126,453,393
Pleasantville (V)	$2,842,599,318	$28,425,993	$142,129,966	$284,259,932
Port Chester (V)	$7,869,067,479	$78,690,675	$393,453,374	$786,906,748
Pound Ridge (T)	$1,596,752,944	$15,967,529	$79,837,647	$159,675,294
Rye (C)	$5,820,922,260	$58,209,223	$291,046,113	$582,092,226
Rye Brook (V)	$4,892,231,021	$48,922,310	$244,611,551	$489,223,102
Scarsdale (T)	$4,603,749,394	$46,037,494	$230,187,470	$460,374,939
Sleepy Hollow (V)	$1,990,885,470	$19,908,855	$99,544,274	$199,088,547
Somers (T)	$6,092,204,344	$60,922,043	$304,610,217	$609,220,434
Tarrytown (V)	$7,284,273,569	$72,842,736	$364,213,678	$728,427,357
Tuckahoe (V)	$1,530,366,709	$15,303,667	$76,518,335	$153,036,671
White Plains (C)	$61,499,698,595	$614,996,986	$3,074,984,930	$6,149,969,860
Yonkers (C)	$50,644,348,876	$506,443,489	$2,532,217,444	$5,064,434,888
Yorktown (T)	$19,503,786,796	$195,037,868	$975,189,340	$1,950,378,680
Westchester County (Total)	**$402,945,561,577**	**$4,029,455,616**	**$20,147,278,079**	**$40,294,556,158**

Source: Westchester County GIS 2020; NYS GIS 2021; RS Means 2021
**aggregate Pelham V and Pelham Manor V = Pelham T*

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 Flood). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with the 1-percent annual chance flood.

Impact on Critical Facilities

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 2020).

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 (NSSL 2021).

Further, 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 2020).

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. In addition to snow removal costs, severe winter weather affects the ability of persons to commute into and out of the area for work or school. The loss of power and closure of roads prevents the commuter population traveling to work within and outside of the County and may cause a loss in economic productivity.

Impact on the Environment

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

Severe winter weather can have a major impact on the environment. Not only does winter weather create changes in natural processes, the residual impacts of a community's methods to maintain its infrastructure through winter weather maintenance may also have an impact on the environment. For example, an excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources (USGS 2020). Rain-on-snow events can also exacerbate runoff rates with warming winter weather. Consequentially, these flow rates and excess volumes of water can erode banks, tear apart habitat along the banks and coastline, and disrupt terrestrial plants and animals.

Cascading Impacts on Other Hazards

Severe winter weather events may exacerbate flooding. As discussed, the freezing and thawing of snow and ice associated with winter weather events can create major flooding issues in the County. Maintaining winter weather hazards through snow and ice removal could minimize the potential risk of flooding during a warming period. Refer to 5.4.3 (Flood) for more information about the flood hazard of concern.

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 Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth located could be potentially impacted by severe winter weather events. Current New York State land use and building codes incorporate standards that address and mitigate snow accumulation. Some local municipalities in the State have implemented the following activities to eliminate loss of life and property and infrastructure damages during winter storm events:

- Removal of snow from roadways
- Removal of 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
- Removal of 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 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 2019).

Projected Changes in Population

According to the U.S. Census Bureau, the population in Westchester County has increased by approximately 2-percent between 2010 and 2019 (US Census n.d.). Additionally, estimated population projections provided by the 2017 Cornell Program on Applied Demographics indicates that the County's population will continue to increase in 2030, increasing the total population to approximately 1,037,234 and then increasing again into 2040 to a population of 1,064,958 (Cornell University 2017). Any growth can create changes in density throughout the County, which may impact the ability of persons in the County to mobilize or receive essential services during severe winter storm events. Historically, winter weather events with associated snowfall and ice accumulation have severely impacted transportation corridors as well as infrastructure. Refer to Section 4 (County Profile), which includes a more thorough discussion about population trends for the County.

Climate Change

As discussed above, most studies project that the State of New York will see an increase in average annual temperatures and precipitation. Annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to freeze into heavy snowfall and icing. This increase in snow and ice could result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by severe winter events due to loss of service or access.

Change of Vulnerability Since 2015 HMP

Since the 2015 analysis, population statistics have been updated using the 5-Year 2015-2019 American Community Survey Population Estimates. Additionally, this updated analysis estimated exposure and losses at the structure level with updated building stock data. The general building stock was updated using building stock data provided by the County to update the user-defined facility inventory and critical facility inventory dataset. The replacement cost value of these structures was updated using RS Means 2019 building valuations.

Overall, this vulnerability assessment uses a more accurate and updated building inventory which provides more accurate estimated exposure and potential losses for Westchester County.