



## 5.4.9 Severe Storm

This section provides a profile and vulnerability assessment of the severe storm hazard for Monroe County.

### 5.4.9.1 Hazard Profile

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

#### Hazard Description

Severe storm events are a common occurrence in Monroe County. A variety of severe storm types, such as thunderstorms, lightning, hail, tornadoes, high winds, and tropical cyclones have damaged property and infrastructure, disrupt power, downing trees and power lines, and causing injuries and fatalities. The following section describes the different severe storm types that impact Monroe County.

#### Thunderstorms

Thunderstorms can lead to flooding, landslides, strong winds, and lightning. Roads could become impassable from flooding, downed trees or power lines, or a landslide. Downed utility poles can lead to utility losses, such as electricity, phone, and water (from loss of pumping and filtering capabilities).

A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS, National Weather Service Glossary 2021). A thunderstorm forms from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as a warm and cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. Although thunderstorms generally affect a small area when they occur, they have the potential to become dangerous due to their ability in generating tornadoes, hailstorms, strong

winds, flash flooding, and lightning. The NWS considers a thunderstorm *severe* only if it produces damaging wind gusts of 58 mph or higher or large hail one inch (quarter size) in diameter or larger or tornadoes (NWS, National Weather Service Glossary 2021).

#### Lightning

Lightning is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. Lightning ranks as one of the top weather killers in the United States, killing approximately 50 people and injuring hundreds each year. Lightning can occur anywhere there is a thunderstorm. Lightning can be cloud to air, cloud to cloud, and cloud to ground.

Lightning can damage homes and injure people. In the United States, an average of 300 people are injured and 80 people are killed by lightning each year. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the United States, with approximately 10 percent of them classified as severe. During the warm season, thunderstorms are responsible for most of the rainfall.

#### Hailstorms

Hail forms inside a thunderstorm where there are strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32 °F or colder. As the frozen droplet begins to fall, it might thaw as it moves into warmer air toward the bottom of the thunderstorm, or the droplet might be picked up again by another updraft and carried back into the cold air to re-freeze. With each trip above and below the freezing level, the frozen



droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail (NSSL 2021).

### High Winds

Wind begins with differences in air pressures. It is rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated by other severe weather events such as thunderstorms, tornadoes, hurricanes, and tropical storms (NWS, Air Pressure and Wind 2012).

### Tornadoes

A tornado is a violently rotating column of air that extends from a thunderstorm to the ground with an average forward speed of 30 miles per hour (mph). Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes can occur at any time of the year, with peak seasons at different times for different states (NWS, Thunderstorms, Tornadoes, Lightning...Nature's Most Violent Storms 2010).

### Tropical Cyclones

Tropical cyclones (hurricanes) are fueled by a different heat mechanism than other cyclonic windstorms such as nor'easters and polar lows. The characteristic that separates a tropical storm from another cyclonic system is that at any height in the atmosphere, the center of a tropical storm will be warmer than its surroundings, a phenomenon called "warm core" storm systems (NOAA 2011) Tropical cyclones strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. Tropical cyclones begin as disturbed areas of weather, often referred to as tropical waves. As the storm organizes, it is designated as a tropical depression.

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds of 39 to 73 mph and heavy rain. A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 mph or higher. Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic coast of the United States and impact the eastern seaboard or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England before moving offshore and heading east.

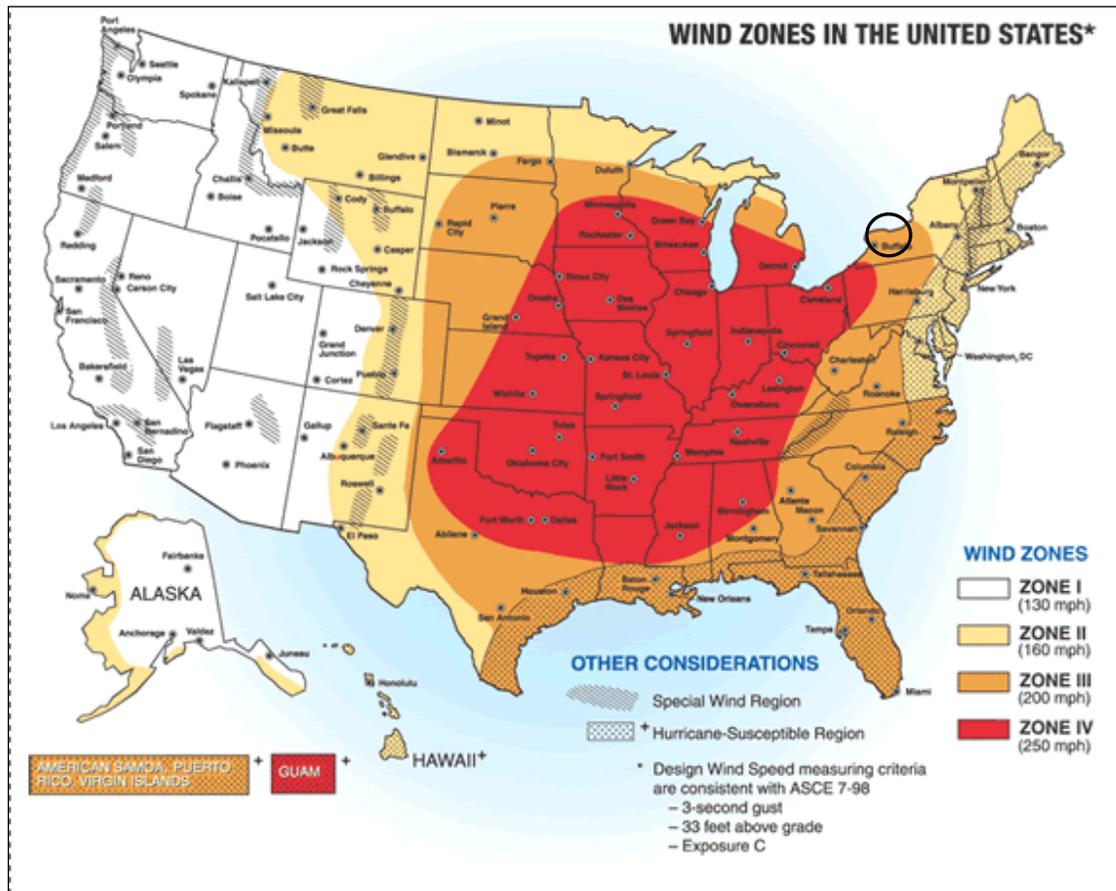
### Location

All of Monroe County is exposed to thunderstorms, lightning, hailstorms, high winds, tornadoes, and tropical cyclones. Monroe County is located in Western New York State; its entire northern border is Lake Ontario. Despite Monroe County's inland location, coastal storms, such as hurricanes and tropical storms, can impact the County. Hurricanes and tropical storms can impact Monroe County from June to November, the official eastern U.S. hurricane season; however, late July to early October is the most likely period for hurricanes and tropical storms to impact the County when North Atlantic Ocean waters are warmest (NYS DHSES 2019) Although one of the most severe impacts associated with hurricanes is storm surge, due to Monroe County's location, storm surge is not a concern for the County and has not been detailed in this profile.

According to the FEMA Winds Zones of the United States map, Monroe County is located within Wind Zone III where wind speeds can reach up to 200 mph. Figure 5.4.9-1 illustrates wind zones across the United States, which indicate the impacts of the strength and frequency of wind activity per region. The information on the figure is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA.



Figure 5.4.9-1. Wind Zones in the United States



Source: FEMA 2012

Note: The black oval indicates the approximate location of Monroe County.

### Extent

The extent (severity or magnitude) of a severe storm is largely dependent upon the most damaging aspects of each type of severe weather. This section describes the extent of thunderstorms, lightning, hail, windstorms, tornadoes, and tropical cyclones in Monroe County.

### Thunderstorms

Severe thunderstorm watches and warnings are issued by the local NWS office and the Storm Prediction Center (SPC). The NWS and SPC will update the watches and warnings and notify the public when they are no longer in effect. NWS issues statements, watches, and warnings for thunderstorms:

- Special Weather Statement: Issued for strong storms that are below severe levels but may have impacts. Usually reserved for the threat of wind gust of 40-58 mph or small hail <1 inch.
- Severe Thunderstorm Watch: Severe thunderstorms with large hail, damaging winds, and/or tornadoes are possible, but the exact time and location of storm development is still uncertain. A watch means be prepared for storms.
- Severe Thunderstorm Warning: A severe thunderstorm is imminent or occurring; it is either detected by weather radar or reported by storm spotters. A severe thunderstorm is one that produces winds 58 mph or stronger and/or hail 1 inch in diameter or larger. A warning means to take shelter (NWS 2020)



Figure 5.4.9-2 presents the severe thunderstorm risk categories, as provided by the SPC.

Figure 5.4.9-2. Severe Thunderstorm Risk Categories

Understanding Severe Thunderstorm Risk Categories					
<b>THUNDERSTORMS</b> (no label)	<b>1 - MARGINAL</b> (MRGL)	<b>2 - SLIGHT</b> (SLGT)	<b>3 - ENHANCED</b> (ENH)	<b>4 - MODERATE</b> (MDT)	<b>5 - HIGH</b> (HIGH)
No severe* thunderstorms expected	Isolated severe thunderstorms possible	Scattered severe storms possible	Numerous severe storms possible	Widespread severe storms likely	Widespread severe storms expected
Lightning/flooding threats exist with all thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense
<ul style="list-style-type: none"> <li>Winds to 40 mph</li> <li>Small hail</li> </ul>	<ul style="list-style-type: none"> <li>Winds 40-60 mph</li> <li>Hail up to 1"</li> <li>Low tornado risk</li> </ul>	<ul style="list-style-type: none"> <li>One or two tornadoes</li> <li>Reports of strong winds/wind damage</li> <li>Hail ~1", isolated 2"</li> </ul>	<ul style="list-style-type: none"> <li>A few tornadoes</li> <li>Several reports of wind damage</li> <li>Damaging hail, 1 - 2"</li> </ul>	<ul style="list-style-type: none"> <li>Strong tornadoes</li> <li>Widespread wind damage</li> <li>Destructive hail, 2" +</li> </ul>	<ul style="list-style-type: none"> <li>Tornado outbreak</li> <li>Derecho</li> </ul>
<small>* NWS defines a severe thunderstorm as measured wind gusts to at least 58 mph, and/or hail to at least one inch in diameter, and/or a tornado. All thunderstorm categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.</small>					

Source: NOAA SPC 2017

### Lightning

Lightning is associated with moderate to severe thunderstorms. Lightning severity is determined by the frequency of lightning strikes during a storm. The New York City Office of Emergency Management notes that lightning strikes occur with moderate frequency in the State of New York, with 3.8 strikes occurring per square mile each year. Multiple devices are available to track and monitor the frequency of lightning (NYC Emergency Management 2020).

### Hailstorms

The severity of hail is measured by duration, hail size, and geographic extent. Hail can exhibit a variety of sizes, though only the very largest hail stones pose serious risk to people, if exposed (DHSES 2019). The size of hail is estimated by comparing it to a known object. The Tornado and Storm Research Organization (TORRO) Hailstorm Intensity Scale (H0 to H10) relates typical damage and hail sizes. Refer to Appendix H (Supplementary Data) for a table that outlines the TORRO scale.

### High Winds

The following table provides the descriptions of winds and their associated sustained wind speed used by the NWS during wind-producing events. The Beaufort wind scale, developed in 1805, is also used today to classify wind conditions, and is provided in Appendix H (Supplementary Data).

Figure 5.4.4-3. Hail Size Chart





Table 5.4.9-1. NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (mph)
Strong, dangerous, or damaging	≥40
Very Windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Source: NWS 2010  
mph miles per hour

The NWS issues advisories and warnings for winds that are typically site-specific. The NWS issues high wind advisories, watches, and warnings when wind speeds can pose a hazard or are life threatening. The criterion for each of these varies from state to state. According to the NWS (2020), wind warnings and advisories for New York State are as follows:

- *High Wind Warnings* are issued when sustained wind speeds of 40 mph or greater lasting for one hour or longer or for winds of 58 mph or greater for any duration or widespread damage are possible.
- *Wind Advisories* are issues when sustained winds of 30 to 39 mph are forecast for one hour or longer, or wind gusts of 46 to 57 mph for any duration.

Tornadoes

The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). This is the scale now used exclusively for determining tornado ratings by comparing wind speed and actual damage. Figure 5.4.9-4 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Tornado watches and warning are issued by the local NWS office. A tornado watch is released when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA SPC 2018).



Figure 5.4.9-4 Explanation of EF-Scale Ratings

EF Rating	Wind Speeds	Expected Damage	
<b>EF-0</b>	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.	
<b>EF-1</b>	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.	
<b>EF-2</b>	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.	
<b>EF-3</b>	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.	
<b>EF-4</b>	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.	
<b>EF-5</b>	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.	

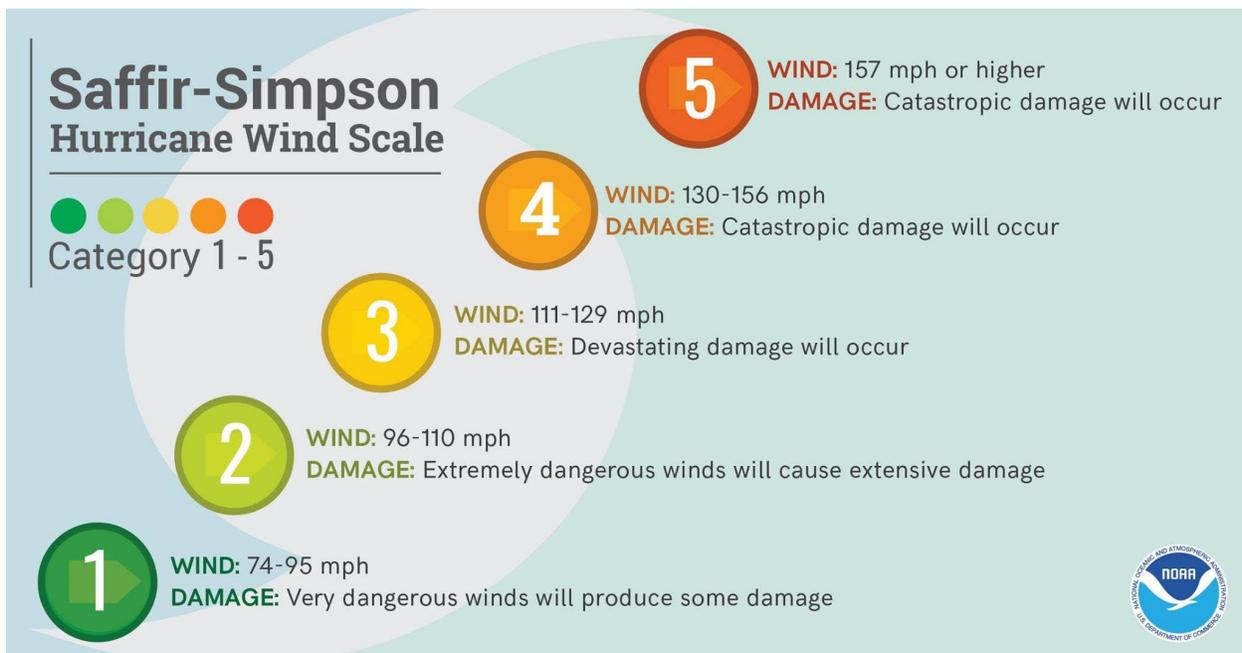
Source: NOAA 2020

### Tropical Cyclones

The extent of a hurricane or tropical storm is commonly categorized in accordance with the Saffir-Simpson Hurricane Wind Scale, which assigns a designation of tropical storm for storms with sustained wind speeds below 74 mph and a hurricane category rating of 1–5 based on a hurricane’s increasing sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered *major hurricanes* because of their potential for significant loss of life and damage. Tropical Storms and Category 1 and 2 storms are still dangerous and require preventative measures (NOAA 2020). Figure 5.4.9-5 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall. Most tropical cyclones that impact Monroe County are remnants of former tropical storms or hurricanes.



Figure 5.4.9-5 The Saffir-Simpson Scale



### Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with severe storms throughout New York State and Monroe County; therefore, the loss and impact information for many events varies depending on the source. The accuracy of monetary figures discussed is based on the available information in cited sources.

### FEMA Major Disaster and Emergency Declarations

Between 1954 and 2022, New York State was included in 45 FEMA declared severe storm or hurricane specific disasters (DR) or emergency declarations (EM). Monroe County was included in 5 of these 45-related declarations (Table 5.4.9-2). In addition, Monroe County was included in a special hurricane related emergency declaration for support for the Hurricane Katrina evacuation in 2005.

Table 5.4.9-2. FEMA DR and EM Declarations for Severe Storm Events in Monroe County, 1954 to 2020

FEMA Declaration Number	Date(s) Of Event	Event Type	Details
DR-1244	September 7, 1998	Severe Weather	New York - Severe Weather
DR-1233	June 25, 1998 - July 10, 1998	Severe Weather	New York Severe Storms and Flooding
DR-1534	May 13, 2004 - June 17, 2004	Severe Weather	New York Severe Storms and Flooding
DR-1564	August 13, 2004 - September 16, 2004	Severe Weather	New York Severe Storms and Flooding
EM-3351	Oct 27, 2012 - Nov 8, 2012	Hurricane	New York Hurricane Sandy

Source: FEMA 2022



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 2015 and 2022, Monroe County was included in the following USDA-designated agricultural disasters that included or may have included losses due to severe storms:

- S3885 - 2015 Excessive Rain, High Winds, Hail, Lightning, and Tornado
- S4595 - 2019 Hail (USDA 2022)

The USDA crop loss data provide another indicator of the severity of previous events. Additionally, crop losses can have a significant impact on the economy by reducing produce sales and purchases. Such impacts may have long-term consequences, particularly if crop yields are low the following years as well. USDA records indicate that Monroe County has experienced crop losses from severe storm events in the years when USDA disasters were declared. Table 5.4.9-3 provides details regarding crop losses in Monroe County according to USDA records.

Table 5.4.9-3. USDA Crop Losses from Severe Storms in Monroe County (2015-2022)

Year	Crop Type	Cause of Loss	Losses
2015	Apples	Hail	\$57,906
2015	Apples	Wind/Excess Wind	\$29,122
2015	All Other Crops	Hail	\$3,870
2019	Corn	Wind/Excess Wind	\$5,112
2019	Apples	Hail	\$23,503

Source: USDA 2022

Previous Events

Table 5.4.9-4 identifies the known severe storm events that impacted Monroe County between 2015 and 2022. For events prior to 2015, refer to Appendix H (Supplementary Data). For detailed information on damages and impacts to each municipality, refer to Section 9 (Jurisdictional Annexes).



Table 5.4.9-4. Severe Storm Events in Monroe County, 2015 to 2022

Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
January 4, 2015	High Wind	N/A	N/A	Monroe County	Deepening low pressure tracked from western Lake Erie across far southern Ontario to Quebec dragging a cold front across the region. Strong winds increased to near 60 mph about two to three hours after the cold front passage. The strong winds downed trees and wires across western New York. Scattered power outages resulted. Some specific damage locations included St. Paul Boulevard in Irondequoit. The County experienced an estimated \$20,000 in property damage.
April 10, 2015	High Wind	N/A	N/A	Monroe County	In the wake of a cold front, strong, damaging winds developed across parts of the area mainly downwind of Lakes Erie and Ontario. Wind gusts were measured to 62 mph at the Buffalo Airport, 60 mph at the Rochester Coast Guard and 58 mph at the Niagara Falls and Rochester Airports. The winds downed trees and powers lines across the eight county area. Tens of thousands were without power. The County experienced an estimated \$20,000 in property damage.
May 27, 2015	Thunderstorm Wind	N/A	N/A	Riga, Severance	A line of thunderstorms crossed the Niagara Frontier and western Finger Lakes during the evening hours. Two storms merged over Monroe County and produced isolated damage. Trees and power lines were reported downed by thunderstorm winds near Churchville and Chili. Law enforcement reported trees and wires down by thunderstorm winds in the Town of Riga and Severance. Property damage was an estimated \$25,000.
June 10, 2015	Thunderstorm Wind, Hail	N/A	N/A	Ogden, Gates, Chili, Maplewood, Henrietta, Pittsford, Blackwatch Hills, Bushnell Basin	<p>Thunderstorms developed along outflow boundary in a warm, humid airmass during the late evening hours. The thunderstorms produced damaging winds and large hail. Although wind gusts were measured to 58 mph at the Rochester airport, after a NWS survey of the damage it was estimated that wind gusts were probably 65 to 70 mph. The storms produced a swath of damage extending across southern Monroe. The storms downed trees and power lines throughout a three-county region with several reports of significant structural and property damage. Hail, up to one inch in diameter, was reported in Fairport. The NWS surveyed damage in Ogden Center, Gate, Chili, Henrietta, Pittsford, Fairport and Bushnell Basin.</p> <p>Law enforcement reported numerous trees and wires down from thunderstorm winds near Ogden Center in the Town of Ogden. Social media contained reports of numerous trees and wires down from thunderstorm winds near Gates. Law enforcement reported numerous trees and wires down from thunderstorm winds near Chili Center. Thunderstorm winds downed trees and poles at the Double Tree Hotel near Henrietta. Several cars were damaged by downed trees in Henrietta. Law enforcement reported numerous trees and wires down from thunderstorm winds near Pittsford. A power transformer was damage near South Main Street and Mile Post Lane. Social media showed numerous reports of downed trees and wires in Bushnell Basin. The County experienced an estimated \$130,000 in property damage.</p>
June 12, 2015	Thunderstorm Wind	N/A	N/A	North Rush	Two lines of showers and thunderstorms moved across the region during the afternoon and early evening hours. The strong thunderstorms produced damaging winds that downed trees and powers lines across the western southern tier and Finger Lakes region.



Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
					Law Enforcement reported trees and wires downed by thunderstorm winds on East River Road. The County experienced an estimated \$10,000 in property damage.
June 23, 2015	Thunderstorm Wind	N/A	N/A	Honeoye Falls, Rush, Mendon	An area of showers and thunderstorms moved across the lower Great Lakes region during the overnight and very early morning hours. The first round of showers moved across southern Ontario and cross the Buffalo area before moving across the Genesee Valley and western Finger Lakes. The second round moved across Lake Erie into the western southern tier. The thunderstorms produced strong winds that downed trees and power lines. Several of the downed trees damage structures and cars. Some roads were temporarily blocked by debris.  News reports of trees and wires downed by thunderstorm winds at Honeoye Falls Airport were received. Law enforcement reported trees and wires downed by thunderstorm winds in Rush and Mendon. The County experienced an estimated \$30,000 in property damage.
July 7, 2015	Thunderstorm Wind	N/A	N/A	Spencerport	Thunderstorms accompanied the passage of a cold front across the region. Thunderstorm winds produced wind gusts that downed trees and power lines. Damage from downed trees was reported in Spencerport. Winds were estimated near 60 mph. Total property damage was an estimated \$15,000.
January 10, 2016	High Wind	N/A	N/A	Monroe County	On Sunday, January 10th, deep low pressure crossed Ohio during the morning, southern Ontario through the day, reaching Quebec Sunday evening. The system dragged a cold front across the region during the late afternoon hours. Ahead of the cold front, southeast wind resulted in downslope wind off the Chautauqua Ridge. Across the entire south shore of Lake Ontario, winds increased following the front. The strong winds brought down trees and power lines. Utilities reported thousands without power scattered throughout the region. Some of the falling trees damaged homes and automobiles. Specific wind gusts downwind of Lake Ontario included 58 mph at Rochester Airport. The County experienced an estimated \$15,000 in property damage.
May 29, 2016	Thunderstorm Wind	N/A	N/A	Mumford	With warm, humid air in place, the passage of an upper air disturbance initiated scattered showers and thunderstorms across the region. Some of these storms reached produced damaging wind gusts that downed trees and power lines. Law enforcement reported a large tree downed by thunderstorm winds at the intersection of Oatka Creek Road and Route 36. Total property damage was an estimated \$15,000.
June 20, 2016	Hail	N/A	N/A	Brighton	Thunderstorms developed ahead of an approaching cold front. Several of the storms produced three quarter inch hail near Brighton.
July 1, 2016	Thunderstorm Wind	N/A	N/A	Rochester, Penfield	Thunderstorms developed as a cold front interacted with the lake breezes off Lakes Erie and Ontario. Nickel-sized hail fell in Bemus Point, Chautauqua County, and near Shelby, Orleans County. Thunderstorms the moved into Monroe County briefly pulsed up and produced damage in Rochester and Penfield before rapidly weakening. In Rochester, a tree fell onto a house on Meredith Street. In Penfield, several large tree limbs were downed. One falling tree caused minor structural damage to the corner of a house. Total property damage was an estimated \$35,000.



Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
August 13, 2016	Thunderstorm Wind	N/A	N/A	Greece, Brighton	Numerous thunderstorms developed on outflow and lake breeze boundaries. The thunderstorms downed trees and wires throughout the region. Law enforcement reported wires downed by thunderstorm winds in Greece and Brighton. Total property damage was an estimated \$10,000.
January 11, 2017	High Wind	N/A	N/A	Monroe County	Gusty winds accompanied the passage of a deepening storm system crossing the upper Great Lakes. Wind gusts were measured to 58 mph at Rochester Airport. The strong winds downed trees and power lines. In the region, several thousand customers were without power. Numerous roads were closed because they were blocked by fallen trees. Total property damage was an estimated \$125,000.
March 1-2, 2017	High Wind	N/A	N/A	Monroe County	Strong winds followed the passage of a cold front across the area. The winds increased during the evening hours of March first before subsiding by daybreak on the second. Gusts as high as 64 mph were measured. The strong winds downed trees and power lines throughout the region. Falling trees damaged homes or automobiles in: Rochester (on North Clinton Avenue), Webster, and Irondequoit. Measured wind gusts included 64 mph at Rochester Airport. \$40,000 in property damages were reported.
March 8, 2017	High Wind	N/A	N/A	Monroe County	Unusually deep low pressure moved from northwest Ontario across Hudson Bay. The low brought strong winds to the entire region with sustained winds up to 49 mph and wind gusts as high as 81 mph. A significant amount of damage resulted with hundreds of thousands left without power, over 100,000 in Monroe County alone. Trees and power lines were downed. Power poles were snapped. In Chili, a large section of fence was impaled into the second story of a house. Numerous flights into the Buffalo and Rochester Airports had to be diverted due to the winds. This in turn resulted in cancellation of some outbound flights from those airports. Measured wind gusts included: 81 mph at Rochester Airport (Monroe County), 67 mph at Brockport (Monroe County), and 47 mph at Gates (Monroe County). Falling trees damaged homes or automobiles in Irondequoit, Braddock Bay, Webster and Brighton (Monroe County). \$1.5 million in property damages were reported.
April 4, 2017	High Wind	N/A	N/A	Monroe County	Strong winds followed the passage of a cold front across the area. The winds increased during the afternoon hours and evening hours of April 4th. Wind gusts as high as 59 mph were measured. The strong winds downed trees and power lines throughout the region. A portion of Route 19 in Warsaw was closed by downed trees and wires. \$30,000 in property damage was reported.
May 1, 2017	Thunderstorm Wind	N/A	N/A	Gates	Thunderstorm winds downed trees on Pasadena Drive and knocked a tree onto a house on Tarwood Drive in Gates. Total property damage was an estimated \$35,000.
May 14, 2017	Hail	N/A	N/A	Rochester	A thunderstorm moving across the Finger Lakes dropped pea- to dime-sized hail on Rochester and the southeast suburbs, including the annual Lilac Festival.
June 15, 2017	Thunderstorm Wind	N/A	N/A	Mendon	Under the influence of a warm, moist airmass, thunderstorms developed across western and north-central New York. Law enforcement reported trees and wires downed by thunderstorm winds in Mendon. Total property damage was an estimated \$14,000.
June 18, 2017	Thunderstorm Wind	N/A	N/A	Scottsville, Brighton	Broadcast media reported trees and wires downed by thunderstorm winds on Quaker Road in Scottsville. Total property damage was an estimated \$10,000. Social media had reported of trees and wires downed by thunderstorm winds in Brighton. Total property damage was estimated at \$12,000.



Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
July 8, 2017	Lightning	N/A	N/A	Monroe County	A cold front slowly advanced its way across the eastern Great Lakes region during the overnight and early morning hours. The thunderstorms produced damaging winds and large hail. The thunderstorm winds downed trees and power lines. Route 183 near Williamstown and Route 11 in Hastings were blocked by debris. Two homes in Monroe County, one in Brockport on Monroe-Orleans County Line Road and one in Penfield on Pipers Meadow Trail, were struck by lightning during the pre-dawn hours. All occupants were able to get out without injury. Total property damage was an estimated \$45,000.
July 24, 2017	Lightning	N/A	N/A	Rochester Airport	Thunderstorms developed during the early morning hours along a warm front extending across the Genesee Valley and Finger Lakes. A lightning strike hit the Air Traffic Control Tower. No one was injured or evacuated and flights were not affected however smoke was reported in the air traffic control room. \$5,000 in property damage was reported.
August 1, 2017	Hail	N/A	N/A	Spencerport	Thunderstorms developed in afternoon summertime warmth and humidity. One of the storms that developed along the boundary of the Lakes Erie and Ontario lake breezes produced large hail. Hail up to one inch in diameter was reported in near Spencerport.
August 22, 2017	Thunderstorm Wind	N/A	N/A	Point Pleasant, Henrietta	Three waves of severe storms moved across western and north-central NY making for an almost 8-hour severe event. Law enforcement reported wires downed by thunderstorm winds on Laser Street, as well as trees downed by thunderstorm winds that were blocking Brighton-Henrietta Town Line Road. Total property damage was an estimated \$65,000.
October 15, 2017	Thunderstorm Wind	N/A	N/A	Crittenden, Maplewood, Beechwood, Barnard, Webster, Railroad Mills, Bushnell Basin, Fairport, Blackwatch Hills	Thunderstorms ahead of and along an approaching strong cold front produced damaging winds during the afternoon and early evening hours. The thunderstorm winds downed trees and power lines throughout the region. Wind gusts were measured to 63 mph at Rochester Airport. Law enforcement reported trees and wires downed by thunderstorm winds near Genesee and Vixette Streets. Law enforcement reported wires downed by thunderstorm winds on Wilcox Street and Crombie Street in Beechwood. Law enforcement reported trees and wires downed by thunderstorm winds on West Avenue in Barnard. Law enforcement reported trees and wires downed by thunderstorm winds on Meadow Drive in Webster. Law enforcement reported trees and wires downed by thunderstorm winds on Thornell Road at Railroad Mills. Law enforcement reported trees and wires downed by thunderstorm winds near Mitchell Road and Route 31 at Bushnell Basin. Law enforcement reported trees and wires downed by thunderstorm winds on Crystal Spring Lane in Fairport. Photos of a tree blown down onto a house and car were posted on social media in Blackwatch Hills. Total property damage was an estimated \$100,000.
October 30, 2017	High Wind	N/A	N/A	Monroe County	Low pressure across the mid-Atlantic rapidly intensified as it tracked across central New York. The winds were especially strong along the Lake Ontario shoreline counties. The winds downed trees and power lines. Some structural damage was reported. There were reports road closures due to downed limbs and wires. Several tens of thousands were without power due to scattered outages. Total property damage in the County was estimated at \$35,000.
April 4, 2018	High Wind	N/A	N/A	Barnard	A surface low deepened resulted in damaging wind gusts occurred across the entire area with multiple trees down, wires down, and overturned semis. Multiple trees and wires were reported down throughout the County through the event. A tree fell onto a house in Barnard. Total property damage in the County was estimated at \$40,000.



Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
July 16, 2018	Thunderstorm Wind, Hail	N/A	N/A	Rochester, Penfield, Webster	A very warm and humid air mass was in place across western and north central New York. As is usually the case with an approaching cold front, thunderstorms fired up along a pre-frontal boundary that extended from the Lake Erie shoreline northeast to Rochester. Trees and wires were down on Garland Avenue, Maple Street, and Campbell Street and a tree fell on a house in Rochester. 0.75 inch hail was reported in Penfield. Trees and wires were down in Webster. Total property damage was an estimated \$15,000.
August 6, 2018	Thunderstorm Wind	N/A	N/A	Egypt	Storms developed south of Lake Ontario. A tree fell on a vehicle on Mason Road. Total property damage was an estimated \$10,000.
November 6, 2018	High Wind	N/A	N/A	Spencerport, Brighton, Chili	Strong winds developed behind a cold front. Trees, utility poles, and wires were down in Spencerport, Brighton, and Chili.
January 1, 2019	High Wind	N/A	N/A	Monroe County	The new year was rung in by damaging wind gusts. The early morning saw gusts reported up to 61 mph. Trees and wires were reported down, especially in the western and northern portions of the County. Total property damage was an estimated \$25,000.
February 8, 2019	High Wind	N/A	N/A	Monroe County	Strong and deepening low pressure moved across the Upper Great Lakes with a trailing cold front crossing the region. The track of the low was quite far north, and it tracked more NNE instead of ENE. The wind field aloft decreased quickly after the cold frontal passage, leaving only a very narrow 1-2 hour window just behind the cold front where warning criteria gusts occurred to the northeast of the lakes. Wet ground conditions increased the impact as the roots of trees were weaker because of this. Maximum wind gusts reported during the event included 59 mph at the Rochester Airport. Trees were reported down in many parts of Monroe County. \$15,000 in property damage was estimated.
February 24-25, 2019	High Wind	N/A	N/A	Monroe County	Low pressure over the central Plains rapidly deepened as it moved into the central Great Lakes, ending up as a 970 mb low over western Quebec. A strong cold front trailing the low sliced through western New York trailing it and ushering in very gusty winds. Selected peak wind gusts included 66 mph at Rochester. Damage was reported from the wind. \$50,000 in property damage was estimated.  Many reports were received of trees and wires down throughout the County causing substantial structural damage to homes and businesses. Thousands were reported without power.
March 10, 2019	High Wind	N/A	N/A	Monroe County	A post cold frontal southwest wind event to the northeast of Lake Erie and Lake Ontario. Trees and powerlines were reported down, resulting in \$5,000 in property damage.
May 19, 2019	Hail	N/A	N/A	Webster, Union Hill	Pea to dime sized hail was reported from a thunderstorm in Webster. 0.88 inch hail lasted about three minutes in Union Hill.
August 8, 2019	Hail, Thunderstorm Wind	N/A	N/A	Henrietta, Penfield, Pittsford, East Rochester	Ahead of a strong cold front, storms along a prefrontal trough became severe. 0.75 inch hail was reported in Henrietta and Penfield. A tree was down and blocking Kennedy Road in Penfield. A tree was reported down onto power lines near Jefferson and Eastview Terrace in Pittsford resulting in \$1,000 in property damage. A tree was reported down onto power lines on the 900 block of South Washington in East Rochester resulting in \$1,000 in property damage.
October 31-	High Wind	DR-4472	No	Monroe County	A deepening area of consolidated low pressure tracked from the north shoreline of Lake Erie to Toronto, and then along the northern shoreline of Lake Ontario Thursday evening, October 31st.



Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
November 1, 2019					Immediately behind the front, winds were southwest and channeled across the typical locations northeast of Lake Erie from Dunkirk to the Niagara Frontier and eastward to Rochester. Southwest wind gusts were 45 to 50 mph. Enough damage was done across New York to have a Presidential Disaster Declaration. Heavy rain also brought flooding concerns. All three climate stations broke their daily October 31 records with 1 to 3 inches of rain falling across the CWA. \$600,000 in property damage was reported.
January 12, 2020	High Wind	N/A	N/A	Monroe County	Post-frontal winds mixed well behind an early morning cold front. Widespread non-thunderstorm wind damage was reported in all lakeshore counties from Monroe westward along Lake Ontario. \$20,000 in property damage was reported.
April 13, 2020	High Wind	N/A	N/A	Monroe County	Low pressure strengthened rapidly as it tracked from the mid-Mississippi River Valley resulting in high winds. Trees were reported down in multiple portions of the County resulting in \$10,000 in property damage.
July 29, 2020	Thunderstorm Wind, Tornado	N/A	N/A	Beechwood, Irondequoit, Scottsville	<p>A leading surface boundary sagged from lower Michigan across the Southern Tier and Genesee Valley. Ample moisture pooling evidenced by precipitable water values in excess of 1.5 inches and modest shear generated instability that allowed for thunderstorms to vertically develop into a layer of dry air aloft. This provided the first set of wind damage producing thunderstorms. These storms developed notable rotation, resulting in one tornado in Monroe County. A tree was down onto a parked car on Baycliff Drive in Beechwood. A large tree fell onto a home on Druid Hill Park in Irondequoit. Two trees were down on Quaker Road in Scottsville. Total property damage was an estimated \$17,000.</p> <p>A supercell thunderstorm developed over Genesee County and tracked east-southeast from just south of the interchange of the New York State Thruway and I-490. Scattered tree limb damage consistent with straight line winds was found along the Oatka Creek upon following the path of this storm into Monroe County starting just east of Beulah Road and continuing through Mumford. Damage became more concentrated upon crossing Wheatland Center Road and entering Oatka Creek Park. A grassy field was laid down flat in the opposite direction of the storm motion with tree damage to the south end of the field indicating rotation with several damaged trees having broken to the northeast. Farther east, a partially- flattened corn field with two shallow-rooted uprooted trees along its southern periphery was coupled with several broken trees along a hiking path through Oatka Creek Park indicating opposing directional damage. Scattered damage continued farther east from Oatka Creek Park along Quaker Road south of Scottsville. A second more concentrated area of damage was found near the intersection of Quaker Road and Route 251. Several trees were down along the hillside west of Route 251, into Route 251, and on the property at the southeast corner of Route 251 and Quaker Road. This included at least three uprooted shallow-rooted trees and one approximately five foot diameter broken and twisted hardwood tree along with many downed smaller limbs that indicated a convergent damage path.</p> <p>Due to the fact that the majority of the path of this storm was along Oatka Creek and through the Oatka Creek Park and in an area that is primarily rural, there was no damage to any</p>



Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
					structures. Because of this, the National Weather Service use exclusively tree damage indicators to reach a conclusion of an EF0 strength and maximum wind speed of 75 mph. \$10,000 in property damage was reported.
November 15-16, 2020	High Wind	N/A	N/A	Monroe County	A rapidly intensifying low pressure system pushed a cold front across the area during the latter half of November 15. Along the cold front, shallow convection developed with widespread non-severe hail and widespread wind gusts over 60 mph. In the wake of the front, a second and longer-lasting period of non-convective high winds persisted through much of the evening and into the overnight east of Lake Ontario. Widespread damage was reported from both the thunderstorm winds and non-thunderstorm winds. \$150,000 in property damages were reported.
March 26, 2021	High Wind	N/A	N/A	Monroe County	A compact closed low passed just to the northwest of the area. Non-thunderstorm measured wind gusts included 59 mph at the Rochester Airport. \$10,000 in property damage was reported.
June 21, 2021	Thunderstorm Wind	N/A	N/A	Rush, Henrietta, Bushnell Basin, Railroad Mills, Irondequoit, Beechwood	Storms developed along a pre-frontal trough around midday and moved east across the area. Storms did produce high rainfall rates, but they were moving at a fast enough pace that the overall flooding threat was limited. The main line of storms associated with the pre-frontal trough initiated along a line stretching from Lake Ontario southwest across Lake Erie into eastern Ohio. This line of storms just took off from there with bowing segments and some supracellular development occurring basically across the entire area. Multiple trees and power lines down onto Route 15 near I-390 in Rush. Extensive damage was reported along I-90 near Henrietta. A large tree fell onto a house and significant tree damage reported on I-490 at Route 96 in Bushnell Basin. A half of a dozen trees were blown down or uprooted, with a tree falling onto a house near Highway 31 in Railroad Mills. A few of the trees were snapped off about 25 feet above the ground. Several reports of trees and powerlines down were received in Irondequoit. A large tree was uprooted on Sethland Drive in Beechwood. Total property damage was an estimated \$46,000.
December 11, 2021	High Wind	N/A	N/A	Monroe County	A strong cold front crossed the region. Selected peak wind gusts included 60 mph at Rochester Airport. Strong surface high pressure over the southern Plains amplified the pressure gradient such that a lake seiche did occur on Lake Erie with a smaller one evident on Lake Ontario, as well. Dozens of reports of trees and powerlines down were received, resulting in \$100,000 in property damage.
March 6, 2022	High Wind	N/A	N/A	Monroe County	Low pressure tracked from the upper Great Lakes to Quebec with a trailing cold front crossing the region. Selected wind gust reports included 72 mph at the Rochester Airport. \$100,000 in property damage was reported.
April 25, 2022	Thunderstorm Wind	N/A	N/A	Rochester Airport, Brighton, Beechwood, Fairport	A cold front advanced slowly towards western New York in the afternoon and evening with convection focused along a pre-frontal trough and an outflow boundary ahead of the main cold front. Multiple reports of wind damage were received. Trees and powerlines were reported to be down on Frost Avenue at Rochester Airport. Trees and powerlines were reported to be down on Hawthorne Street in Brighton. Numerous large tree limbs and powerlines were reported to be down in Beechwood. Trees and powerlines were reported to be down at Golf Avenue and Marsh Road in Fairport. \$9,000 in property damage was reported.

Source: NOAA-NCEI 2022; FEMA 2022





### Climate Change Impacts

Climate change is beginning to affect both people and resources in Monroe County, and these impacts are projected to continue growing. 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)

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Monroe County is part of Region 1, Western New York, Great Lakes Plain. In Region 1, it is estimated that temperatures will increase by 3.0 °F to 5.5 °F by the 2050s and 4.5 °F to 8.5 °F by the 2080s (baseline of 48.0 °F, mid-range projection). Precipitation totals will increase between 0 and 10 percent by the 2050s and 0 to 15 percent by the 2080s (baseline of 37.0 inches, mid-range projection). Table 5.4.9-5 displays the projected seasonal precipitation change for ClimAID Region 1 (NYSERDA 2014).

**Table 5.4.9-5. Projected Seasonal Precipitation Change in Region 1, 2050s (% change)**

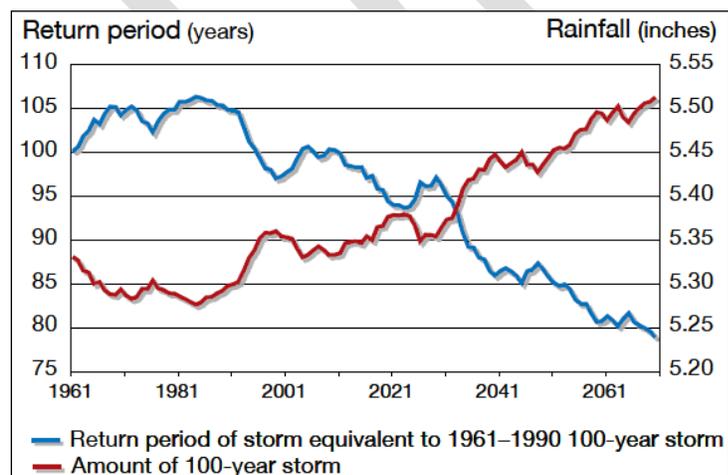
Winter	Spring	Summer	Fall
+5 to +15	0 to +10	-5 to +10	-5 to +10

Source: NYSERDA 2014

The projected increase in precipitation is expected to fall in heavy downpours and less in light rains. Downpours are very likely to increase in frequency and intensity, a change which has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways, and transportation hubs; and increase delays and hazards related to extreme weather events (NYSERDA 2011). Less frequent rainfall during the summer months may impact the ability of water supply systems. Increasing water temperatures in rivers and streams will affect aquatic health and reduce the capacity of streams to assimilate effluent wastewater treatment plants (NYSERDA 2011).

Figure 5.4.9-7 displays the project rainfall and frequency of extreme storms in New York State. The amount of rainfall in a 100-year event is projected to increase, while the number of years between such storms (return period) is projected to decrease. Rainstorms will become more severe and more frequent (NYSERDA 2011).

**Figure 5.4.9-6. Projected Rainfall and Frequency of Extreme Storms**



Source: NYSERDA 2011



Probability of Future Occurrences

Based on the historic and more recent severe storm events in Monroe County, and the future climate projections for this region, the County has a high probability of future severe storm events. It is anticipated that Monroe County will continue to experience direct and indirect impacts of severe storm events annually that may induce secondary hazards such as infrastructure deterioration or failure, utility failures, power outages, and transportation delays, accidents and inconveniences. Additionally, climate change is expected to increase the severity and frequency of severe storm events in Monroe County. According to available record keeping, Monroe County has a 100% annual chance of occurrence of severe storm events in any given year.

Table 5.4.9.1-6. Probability of Future Occurrence of Severe Storm Events

Table with 3 columns: Hazard Type, Number of Occurrences Between 1996 and 2022, and % chance of occurrence in any given year. Rows include Hail, High Wind, Lightning, Thunderstorm Wind, Tornado, and TOTAL.

Source: NOAA-NCEI 2022; FEMA 2022

Note: Disaster occurrences include federally declared disasters and selected severe storm events between January 1, 1996 and January 1, 2022. Due to limitations in data, not all severe storm events occurring between 1996 and 2022 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In addition to the events listed above, six tropical cyclones have passed within 60 nautical miles of Monroe County since 1861 (2 tropical depressions, 3 tropical storms, 1 Category 1 hurricane) resulting in 3.73% chance of occurrence in any given year over the 160-year record keeping (NOAA n.d.).

Section 5.3 ranks the identified hazards of concern for Monroe County. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Steering Committee, the probability of occurrence for severe storms in the County is considered ‘frequent’ (100 percent annual probability; a hazard event may occur multiple times per year).

5.4.9.2 Vulnerability Assessment

A probabilistic assessment was conducted for the 100- year and 500-year MRP hurricane wind event through a Level 2 analysis in Hazus to analyze the severe storm hazard and provide a range of loss estimates due to wind impacts. Section 5.1, Methodology includes additional details on the methodology used to assess the severe storm risk.

Impact on Life, Health, and Safety

The impact of a severe weather event and wind on life, health, and safety is dependent upon several factors, including the severity of the event and whether adequate warning time was provided to residents. For the purposes of this HMP, all of Monroe County is considered vulnerable to a severe weather event and wind impacts (i.e., 753,109 persons total, US Census 2020). Hazus estimates that zero persons will be displaced from their homes or will seek shelter during a 500-year MRP hurricane wind event. Secondary impacts caused by extreme wind events include downed trees, damaged buildings, and debris carried by high winds, which can lead to injury or loss of life.



Socially vulnerable populations are most susceptible to severe weather events based on several factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Vulnerable populations include homeless persons, elderly (over 65 years old), low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. They may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention, which may not be available due to isolation during a storm event. According to the 5-Year 2020 American Community Survey Population Estimates, there are 127,588 persons over 65 and 100,484 persons living in poverty in Monroe County (American Community Survey 2020).

Additionally, people located outdoors (i.e., recreational activities and farming) are considered most vulnerable to hailstorms, thunderstorms, and tornadoes. This is because there is little to no warning, and shelter may not be available. Moving to a lower risk location will decrease a person’s vulnerability. See Section 4, County Profile for population statistics for each participating jurisdiction.

### **Impact on General Building Stock**

Damage to buildings is dependent upon several factors, including wind speed, storm duration, and path of the storm track. Building construction also plays a major role in the extent of damage resulting from a coastal storm. Due to differences in construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Furthermore, high-rise buildings are also very vulnerable structures. Hazus estimates that there will be no damages in the event of a 100-year or 500-year MRP wind event.

### **Impact on Critical Facilities**

Critical facilities are at risk of being impacted by high winds associated with structural damage or falling tree limbs/flying debris, which can result in the loss of power. Power loss can greatly impact households, business operations, public utilities, and emergency personnel. For example, vulnerable populations in Monroe County are at risk if power loss results in interruption of heating and cooling services, stagnated hospital operations, and potable water supplies. Emergency personnel such as police, fire, and emergency medical services (EMS) will not be able to effectively respond in a power loss event to maintain the safety of its citizens.

Hazus estimates the probability that critical facilities (i.e., medical facilities, fire/EMS, police, emergency operation centers [EOC], schools, and user-defined facilities such as shelters and municipal buildings) may sustain damage as a result of the 100-year or 500-year MRP hurricane wind events. Additionally, Hazus estimates the loss of use for each facility in number of days. Overall, Hazus estimates that none of the critical facilities in Monroe County are estimated to experience damage or loss of functionality due to a 100-year or a 500-year MRP hurricane wind event.

### **Impact on Economy**

Severe storm events can have short- and long-lasting impacts on the economy. When a business is closed during storm recovery, there is lost economic activity in the form of day-to-day business and wages to employees. Overall, economic impacts include the loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss, and rental loss due to the repair/replacement of buildings.

Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical



systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the population.

Hazus estimates the total economic loss associated with the 100-year and 500-year MRP hurricane wind events (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the “Impact on General Building Stock” section discussed earlier. Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event. Hazus estimates that there would be no building and content losses in the event of a 500-year MRP wind event.

Debris management can be costly and may also impact the local economy. Hazus estimates the amount of building and tree debris that may be produced as a result of the 100-year and 500-year MRP hurricane wind events. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the Hazus Hurricane User Manual, estimates of weight and volume of eligible tree debris consist of downed trees that would likely be collected and disposed at public expense. Hazus estimates that the 100-year and 500-year MRP hurricane wind event will not cause any debris for Monroe County.

### Impact on the Environment

The impact of severe weather events on the environment varies, but researchers are finding that the long-term impacts of more severe weather can be destructive to the natural and local environment. National organizations such as USGS and NOAA have been studying and monitoring the impacts of extreme weather phenomena as it impacts long-term climate change, streamflow, river levels, reservoir elevations, rainfall, floods, landslides, erosion, etc. (USGS 2020). For example, severe weather that creates longer periods of rainfall can erode natural banks along waterways and degrade soil stability for terrestrial species. Tornadoes can tear apart habitats, causing fragmentation across ecosystems. Researchers also believe that a greater number of diseases will spread across ecosystems because of impacts that severe weather and climate change will have on water supplies (NOAA 2019). Overall, as the physical environment becomes more altered, species will begin to contract or migrate in response, which may cause additional stressors to the entire ecosystem within Monroe County.

### Cascading Impacts on Other Hazards

Severe weather events and severe wind events can escalate the impacts of flooding and utility failure. Severe winds can be destructive to the functionality of utilities by breaching power lines and disconnecting the utility systems. Severe weather may carry extreme rainfall that could exacerbate flooding. More information about flooding can be found in Section 5.4.5 of this HMP.

### Future Changes that May Impact Vulnerability

Understanding future changes that effect vulnerability in the county can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. Changes in the natural environment and built environment and how they interact can also provide insight about ways to plan.

### Projected Development

Any areas of growth could be potentially impacted by the severe storm hazard because the entire county is exposed and vulnerable to the wind hazard associated with severe storms. However, due to increased standards and codes, new development may be less vulnerable to the severe storm hazard compared to the aging building



stock in the county. Please refer to Section 4 and Section 9 for additional information regarding the areas targeted for future growth and development in the County.

### **Projected Changes in Population**

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According to the 2020 Census, the population of the County has increased by approximately 1.2 percent since 2010. The County’s population is anticipated to slightly increase over the next decade (0.7 percent increase by 2030). An increase in population will result in more of the population exposed to the severe storm hazard as it impacts the entire planning area. Refer to Section 4 (County Profile), which includes a discussion on population trends for the County.

### **Climate Change**

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As discussed previously, the entire State of New York is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (NASA 2013). Section 5.4.5, Flood, includes a discussion related to the impact of climate change due to increases in rainfall. An increase in storms will produce more wind events and may increase tornado activity. Additionally, an increase in temperature will provide more energy to produce storms that generate tornadoes (NASA 2013). With an increased likelihood of strong winds and tornado events, all the county’s assets will experience additional risk for losses as a result of extreme wind events.

### **Changes in Vulnerability Since the 2017 HMP**

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Monroe County’s vulnerability to severe storm events has remained unchanged. Since the 2017 HMP analysis, population statistics have been updated using the 2020 Census. The general building stock and the 2017 critical facility dataset was updated by the County and participating jurisdictions. Overall, this vulnerability assessment uses a more accurate and updated building inventory than that used in the 2017 HMP.