5.4.1 SEVERE STORM

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

HAZARD PROFILE

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

Description

For the purpose of this HMP and as deemed appropriated by the County, the severe storm hazard includes hailstorms, windstorms, lightning, thunderstorms, tornadoes, and tropical cyclones (for example, hurricanes, tropical storms, and tropical depressions), which are defined as below. Since most northeasters, (or Nor'Easters) a type of an extra-tropical cyclone, generally take place during the winter weather months, Nor'Easters have been grouped as a type of severe winter weather storm, further discussed in Section 5.4.2 Severe Winter Storm.

Hailstorm: According to the National Weather Service (NWS), hail is defined as a showery precipitation in the form of irregular pellets or balls of ice more than 5 millimeters in diameter, falling from a cumulonimbus cloud (NWS, 2005). Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight; they fall as precipitation, in the form of balls or irregularly shaped masses of ice. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size. Hailstorms are a potential damaging outgrowth of severe thunderstorms (Northern Virginia Regional Commission [NVRC], 2006). They cause over $1 billion in crop and property damages each year in the U.S., making hailstorms one of the most costly natural disasters (Federal Alliance for Safe Homes, Inc., 2006).

Windstorm: According to the Federal Emergency Management Agency (FEMA), wind is air moving from high to low pressure. It is rough horizontal movement of air (as opposed to an air current) caused by uneven heating of the Earth's surface. It occurs at all scales, from local breezes generated by heating of land surfaces and lasting tens of minutes to global winds resulting from solar heating of the Earth. The two major influences on the atmospheric circulation are the differential heating between the equator and the poles, and the rotation of the planet. Windstorm events are associated with cyclonic storms (for example, hurricanes), thunderstorms and tornadoes (FEMA, 1997).

Lightning: According to the NWS, lightning is a visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds or between a rain cloud and the ground (NWS, 2005). The discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm creates a "bolt" when the buildup of charges becomes strong enough. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit (°F). Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder. On average, 89 people are killed and 300 injuries occur each year due to lightning strikes in the U.S. (NVRC, 2006).

Thunderstorm: According to the NWS, a thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS, 2005). 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. These storms occur most commonly in the tropics. Many tropical land-based locations experience over 100 thunderstorm days each year (Pidwirny, 2007). Although thunderstorms generally affect a small area when they occur, they are very dangerous because of their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and damaging lightning. A thunderstorm produces wind gusts less than 57 miles per hour (mph) and hail, if any, of less than 3/4-inch diameter (20 millimeters) at the surface. A severe thunderstorm has thunderstorm related surface winds (sustained or gusts) of 57 mph or greater and/or surface hail 3/4-inch (20 millimeters) or larger (NWS, 2005). Wind or hail damage may be used to infer the occurrence/existence of a severe thunderstorm (Office of the Federal Coordinator for Meteorology, 2001).

Tornado: A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. It is spawned by a thunderstorm (or sometimes as a result of a hurricane) and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. Tornado season is generally March through August, although tornadoes can occur at any time of year (FEMA, 2004). Tornadoes tend to strike in the afternoons and evening, with over 80 percent (%) of all tornadoes striking between noon and midnight (New Jersey Office of Emergency Management [NJOEM], 2005). The average forward speed of a tornado is 30 mph, but can vary from nearly stationary to 70 mph (NWS, 1995). The NOAA Storm Prediction Center (SPC) indicates that the total duration of a tornado can last between a few seconds to over one hour; however, a tornado typical lasts less than 10 minutes (Edwards, 2007). High-wind velocity and wind-blown debris, along with lightning or hail, result in the damage caused by tornadoes. Destruction caused by tornadoes depends on the size, intensity, and duration of the storm. Tornadoes cause the greatest damage to structures that are light, such as residential homes and mobile homes, and tend to remain localized during impact (NVRC, 2006).

Tropical Cyclone: Tropical cyclone is a generic term for a cyclonic, low-pressure system over tropical or sub-tropical waters (National Atlas, 2007); containing a warm core of low barometric pressure which typically produces heavy rainfall, powerful winds and storm surge (New York City Office of Emergency Management [NYCOEM], 2007). It feeds on the heat released when moist air rises and the water vapor in it condenses (Dorrego, Date Unknown). Depending on their location and strength, there are various terms by which tropical cyclones are known, such as hurricane, typhoon, tropical storm, cyclonic storm and tropical depression (Pacific Disaster Center, 2006). While tropical cyclones begin as a tropical depression, meaning the storm has sustained winds below 38 mph, it may develop into a tropical storm (with sustained winds of 39 to 73 mph) or a hurricane (with winds of 74 mph and higher).

Tropical Depression: A tropical depression is an organized system of clouds and thunderstorms with a defined surface circulation and maximum sustained winds of less than 38 mph. It has no "eye" (the calm area in the center of the storm) and does not typically have the organization or the spiral shape of more powerful storms (Emanuel, Date Unknown; Miami Museum of Science, 2000).

Tropical Storm: A tropical storm is an organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds between 39 and 73 mph (FEMA, 2007). Once a storm has reached tropical storm status, it is assigned a name. During this time, the storm itself becomes more organized and begins to become more circular in shape, resembling a hurricane. The rotation of a tropical storm is more recognizable than a tropical depression. Tropical storms can cause a lot of problems, even without becoming a hurricane; however, most of the problems stem from heavy rainfall (University of Illinois, Date Unknown).

Hurricane: A hurricane is an intense tropical cyclone with wind speeds reaching a constant speed of 74 mph or more (FEMA, 2004). It is a category of tropical cyclone characterized by thunderstorms and defined surface wind circulation. They are caused by the atmospheric instability created by the collision of warm air with cooler air. They form in the warm waters of tropical and sub-tropical oceans, seas, or Gulf of Mexico (NWS, 2000). Most hurricanes evolve from tropical disturbances. A tropical disturbance is a discrete system of organized convection (showers or thunderstorms), that originate in the tropics or subtropics, does not migrate along a frontal boundary, and maintains its identity for 24 hours or more (NWS, 2004). Hurricanes begin when areas of low atmospheric pressure move off the western coast of Africa and into the Atlantic, where they grow and intensify in the moisture-laden air above the warm tropical ocean. Air moves toward these atmospheric lows from all directions and circulates clock-wise under the influence of the Coriolis effect, thereby initiating rotation in the converging wind fields. When these hot, moist air masses meet, they rise up into the atmosphere above the low pressure area, potentially establishing a self-reinforcing feedback system that produces weather systems known to meteorologists as tropical disturbances, tropical depressions, tropical storms, and hurricanes (Frankenberg, 2006).

Almost all tropical storms and hurricanes in the Atlantic basin (which includes the Gulf of Mexico and Caribbean Sea) form between June 1 and November 30, known as hurricane season. August and September are peak months for hurricane development. The threats caused by an approaching hurricane can be divided into three main categories: storm surge, wind damage and rainfall/flooding:

- *Storm Surge* is simply water that is pushed toward the shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level 15 feet or more. Storm surge is responsible for nearly 90-percent of all hurricane-related deaths and injuries.
- *Wind Damage* is the force of wind that can quickly decimate the tree population, down power lines and utility poles, knock over signs, and damage/destroy homes and buildings. Flying debris can also cause damage to both structures and the general population. When hurricanes first make landfall, it is common for tornadoes to form which can cause severe localized wind damage.
- *Rainfall / Flooding* the torrential rains that normally accompany a hurricane can cause serious flooding. Whereas the storm surge and high winds are concentrated around the "eye", the rain may extend for hundreds of miles and may last for several days, affecting areas well after the hurricane has diminished (Mandia, 2008).

Extent

The extent (that is, magnitude or severity) of a severe storm is largely dependent upon sustained wind speed. Straight-line winds, winds that come out of a thunderstorm, in extreme cases, can cause wind gusts exceeding 100 mph. These winds are most responsible for hailstorm and thunderstorm wind damage. One type of straight-line wind, the downburst, can cause damage equivalent to a strong tornado (NVRC, 2006).

Tornado

The magnitude or severity of a tornado was originally categorized using the Fujita Scale (F-Scale) or Pearson Fujita Scale introduced in 1971, based on a relationship between the Beaufort Wind Scales (B-Scales) (measure of wind intensity) and the Mach number scale (measure of relative speed). It is used to rate the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure (Tornado Project, Date Unknown). The F-Scale categorizes each tornado by intensity and area. The scale is divided into six categories, F0 (Gale) to F5 (Incredible) (SPC, 2007). Table 5.4.1-1 explains each of the six F-Scale categories.

Table 5.4.1-1. Fujita Damage Scale

Scale	Wind Estimate (MPH)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Source: SPC, Date Unknown

Although the F-Scale has been in use for over 30 years, there are limitations of the scale. The primary limitations are a lack of damage indicators, no account of construction quality and variability, and no definitive correlation between damage and wind speed. These limitations have led to the inconsistent rating of tornadoes and, in some cases, an overestimate of tornado wind speeds. The limitations listed above led to the development of the Enhanced Fujita Scale (EF Scale). The Texas Tech University Wind Science and Engineering (WISE) Center, along with a forum of nationally renowned meteorologists and wind engineers from across the country, developed the EF Scale (NWS, 2007).

The EF Scale became operational on February 1, 2007. It is used to assign tornadoes a 'rating' based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators (DIs) and Degrees of Damage (DOD), which help better estimate the range of wind speeds produced by the tornado. From that, a rating is assigned, similar to that of the F-Scale, with six categories from EF0 to EF5, representing increasing degrees of damage. The EF Scale was revised from the original F-Scale to reflect better examinations of tornado damage surveys. This new scale has to do with how most structures are designed (NWS, 2007). Table 5.4.1-2 displays the EF Scale and each of its six categories.

Table 5.4.1-2. Enhanced Fujita Damage Scale

F-Scale Number	Intensity Phrase	Wind Speed (mph)	Type of Damage Done
EF0	Light tornado	65–85	Light damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.

F-Scale Number	Intensity Phrase	Wind Speed (mph)	Type of Damage Done
EF1	Moderate tornado	86-110	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	Significant tornado	111-135	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	Severe tornado	136-165	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	Devastating tornado	166-200	Devastating damage. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	Incredible tornado	>200	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Source: SPC, 2007

In the Fujita Scale, there was a lack of clearly defined and easily identifiable damage indicators. The EF Scale takes into account more variables than the original F-Scale did when assigning a wind speed rating to a tornado. The EF Scale incorporates 28 damage indicators (DIs), such as building type, structures, and trees. For each damage indicator, there are 8 degrees of damage (DOD), ranging from the beginning of visible damage to complete destruction of the damage indicator. Table 5.4.1-3 lists the 28 DIs. Each one of these indicators has a description of the typical construction for that category of indicator. Each DOD in every category is given an expected estimate of wind speed, a lower bound of wind speed, and an upper bound of wind speed.

Table 5.4.1-3. Enhanced F-Scale Damage Indicators

Number	Damage Indicator	Abbreviation	Number	Damage Indicator	Abbreviation
1	Small barns, farm outbuildings	SBO	15	School - 1-story elementary (interior or exterior halls)	ES
2	One- or two-family residences	FR12	16	School - jr. or sr. high school	JHSH
3	Single-wide mobile home (MHSW)	MHSW	17	Low-rise (1-4 story) bldg.	LRB
4	Double-wide mobile home	MHDW	18	Mid-rise (5-20 story) bldg.	MRB

Number	Damage Indicator	Abbreviation	Number	Damage Indicator	Abbreviation
5	Apt, condo, townhouse (3 stories or less)	ACT	19	High-rise (over 20 stories)	HRB
6	Motel	M	20	Institutional bldg. (hospital, govt. or university)	IB
7	Masonry apt. or motel	MAM	21	Metal building system	MBS
8	Small retail bldg. (fast food)	SRB	22	Service station canopy	SSC
9	Small professional (doctor office, branch bank)	SPB	23	Warehouse (tilt-up walls or heavy timber)	WHB
10	Strip mall	SM	24	Transmission line tower	TLT
11	Large shopping mall	LSM	25	Free-standing tower	FST
12	Large, isolated ("big box") retail bldg.	LIRB	26	Free standing pole (light, flag, luminary)	FSP
13	Automobile showroom	ASR	27	Tree - hardwood	TH
14	Automotive service building	ASB	28	Tree - softwood	TS

Source: SPC, Date Unknown

Since the EF Scale recently went into effect in February 2007, previous occurrences and losses associated with historic tornado events, described in the next section (Previous Occurrences and Losses) of this hazard profile are based on the former Fujita Scale.

Hurricanes

The extent of a hurricane is categorized by the Saffir-Simpson Hurricane Scale. This scale categorizes or rates hurricanes from 1 (Minimal) to 5 (Catastrophic) based on their intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline, in the landfall region (National Hurricane Center [NHC], 2007). Table 5.4.1-4 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes land fall.

Table 5.4.1-4. The Saffir-Simpson Scale

Category	Wind Speed (mph)	Storm Surge (above normal sea level)	Expected Damage
1	74-95	4 – 5 feet	Minimal: Damage is done primarily to shrubbery and trees, unanchored mobile homes are damaged, some signs are damaged, and no real damage is done to structures.

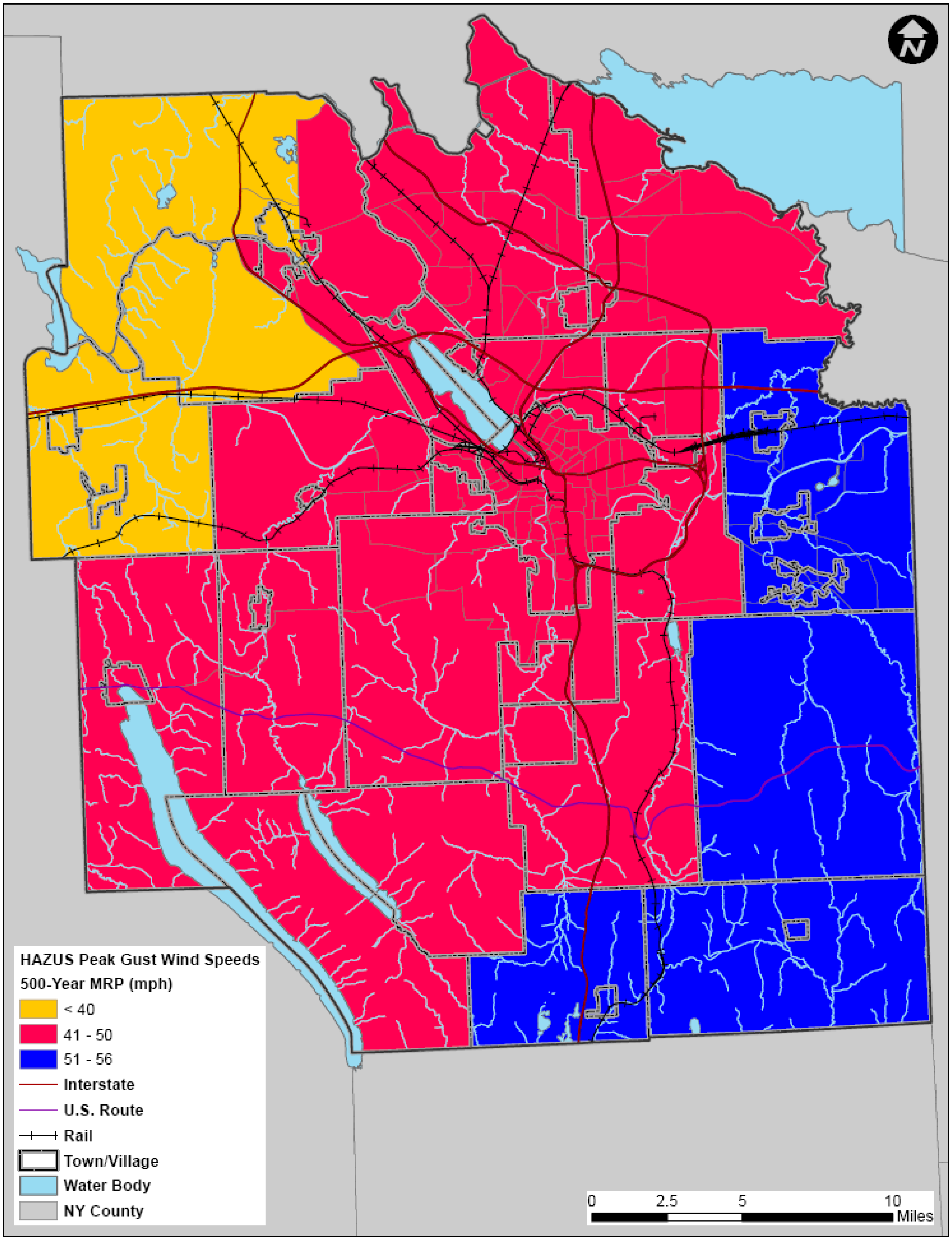
Category	Wind Speed (mph)	Storm Surge (above normal sea level)	Expected Damage
2	96-110	6 – 8 feet	Moderate: Some trees are toppled, some roof coverings are damaged, and major damage is done to mobile homes.
3	111-130	9 – 12 feet	Extensive: Large trees are toppled, some structural damage is done to roofs, mobile homes are destroyed, and structural damage is done to small homes and utility buildings.
4	131-155	13 – 18 feet	Extreme: Extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail; and some curtain walls fail.
5	> 155	> 18 feet	Catastrophic: Roof damage is considerable and widespread, window and door damage is severe, there are extensive glass failures, and entire buildings could fail.
Additional Classifications			
Tropical Storm	39-73	0 - 3 feet	NA
Tropical Depression	< 38	0	NA

Source: FEMA, 2007
mph = Miles per hour
> = Greater than
NA = Not applicable or not available

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event (equal to the inverse of the annual frequency of exceedance) (Dinicola, 2005).

HAZUS-MH MR3 determined that the path of the 100-year MRP hurricane event would travel north along the east coast remaining over the Atlantic Ocean. It does not travel through New York State and therefore the wind speeds that can be anticipated in and around Onondaga County are less than 50 mph, or characteristic of a tropical cyclone or tropical storm. For the 500-year MRP event, HAZUS-MH MR3 estimates the storm track will travel through New York State passing Onondaga County to the southeast. The maximum 3-second gust wind speeds for the County range from 39 to 56 mph for the 500-year MRP event; wind speeds characteristic of tropical storm (Figure 5.4.1-1). The associated impacts and losses from these 100-year and 500-year MRP hurricane event model runs are reported in the Vulnerability Assessment later in this section.

Figure 5.4.1-1. Peak Wind Speeds for 500-year Hurricane Severe Storm Event (Wind) in Onondaga County



Source: HAZUS-MH, 2005

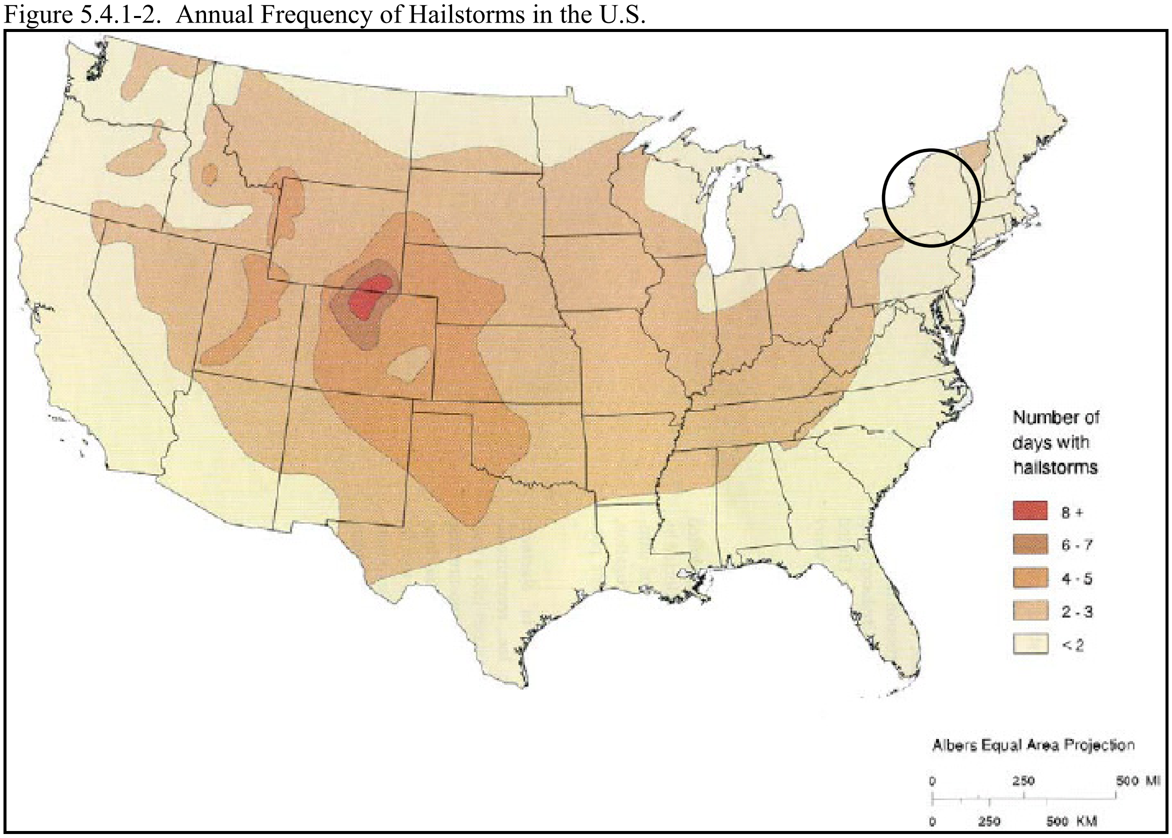
Location

Severe storms are a common natural hazard throughout New York State because it exhibits a unique blend of weather (geographically and meteorological) features that influence the potential for severe storms and associated flooding. Factors include temperature, which is affected by latitude, elevation, proximity to water bodies and source of air masses; and precipitation which includes snowfall and rainfall. Precipitation intensities and effects are influenced by temperature, proximity to water bodies, and general frequency of storm systems. The Cornell Climate Report also indicates that the geographic position of the State (Northeast U.S.) makes it vulnerable to frequent storm and precipitation events. This is because nearly all storms and frontal systems moving eastward across the continent pass through, or in close proximity to New York State. Additionally, the potential for prolonged thunderstorms or coastal storms and periods of heavy precipitation is increased throughout the state because of the available moisture that originates from the Atlantic Ocean (NYSDPC, 2008).

Hailstorms

Hailstorms are more frequent in the southern and central plain states, where the climate produces violent thunderstorms. However, hailstorms have been observed in almost every location where thunderstorms occur (Federal Alliance for Safe Homes, Inc, 2006). Figure 5.4.1-2 illustrates that Onondaga County and most of New York State experience less than two hailstorms per year.

Figure 5.4.1-2. Annual Frequency of Hailstorms in the U.S.

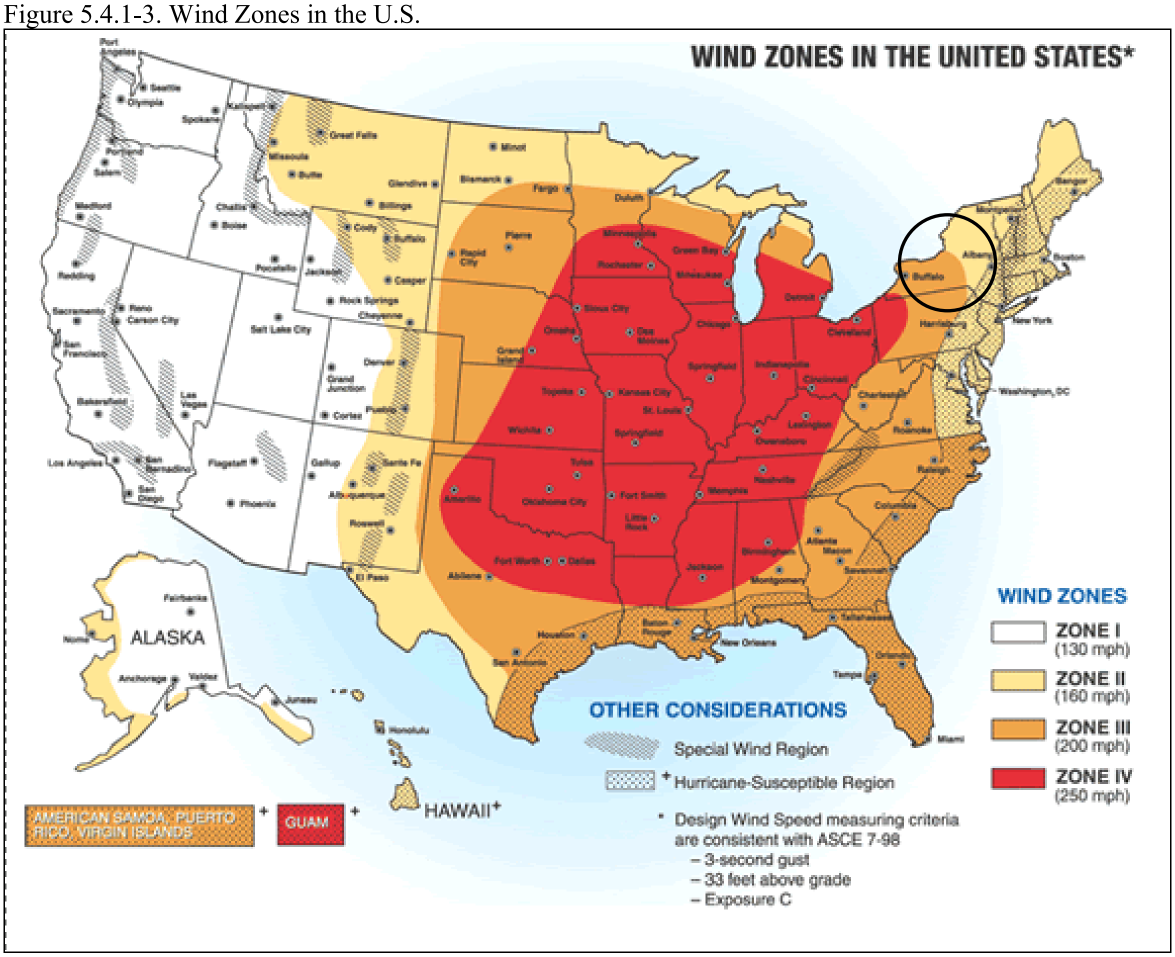


Source: NVRC, 2006
Note: The black circle indicates the approximate location of Onondaga County. Onondaga County experiences less than 2 hailstorms a year.

Windstorms

Figure 5.4.1-3 indicates how the frequency and strength of windstorms impacts the U.S. and the general location of the most wind activity. This is based on 40 years of tornado history and 100 years of hurricane history, collected by FEMA. States located in Wind Zone IV have experienced the greatest number of tornadoes and the strongest tornadoes (NVRC, 2006). Onondaga County is located in Wind Zone III with speeds up to 200 miles per hour (FEMA, 2006). The New York State Hazard Mitigation Plan (NYS HMP) identifies counties most vulnerable to wind, as determined by a rating score. Counties accumulate points based on the value of each vulnerability indicator, the higher then indication for wind exposure the more points assigned, resulting in a final rating score. Onondaga County was given a rating score of 15, a medium to high vulnerability to wind exposure (NYSDPC, 2008).

Figure 5.4.1-3. Wind Zones in the U.S.



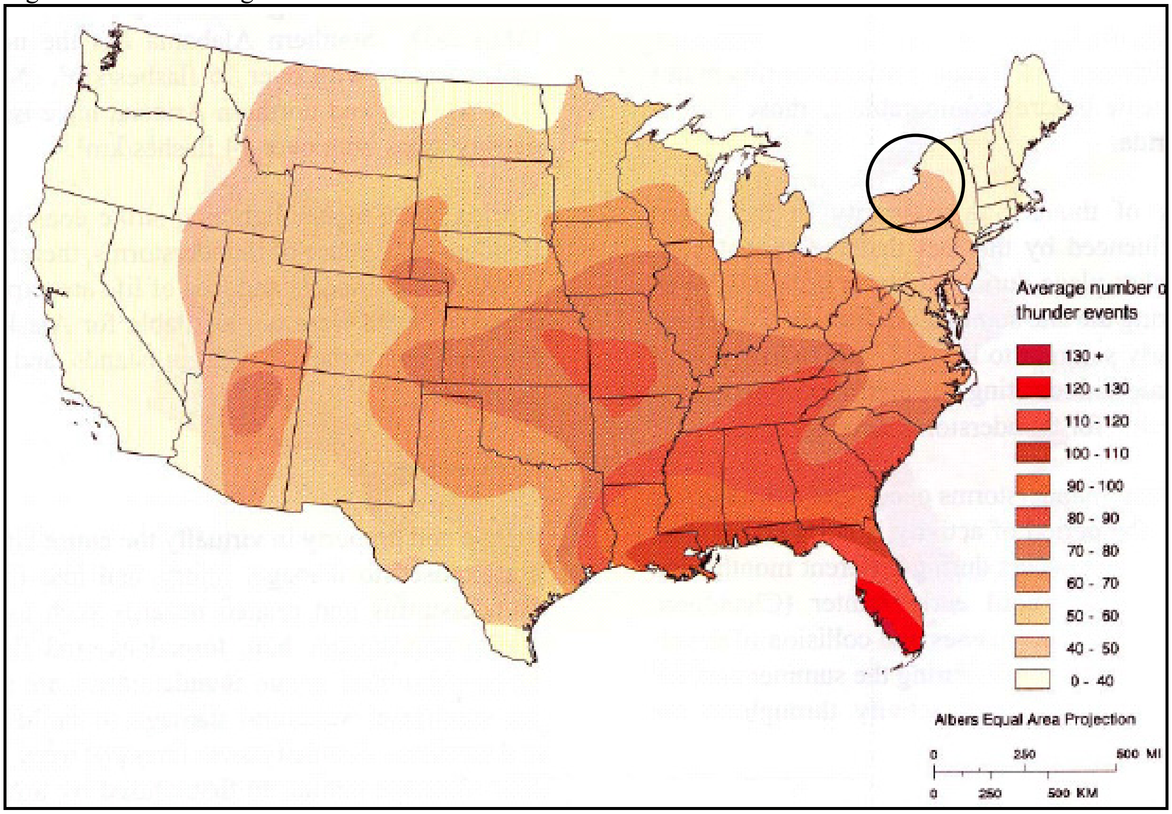
Source: FEMA, 2006

Note: The black circle indicates the approximate location of Onondaga County. Onondaga County is located in Wind Zone III.

Thunderstorms

Thunderstorms affect relatively small localized areas, rather then large regions much like winter storms, and hurricane events (NWS, 2005). Thunderstorms can strike in all regions of the U.S.; however, they are most common in the central and southern states. The atmospheric conditions in these regions of the country are most ideal for generating these powerful storms (NVRC, 2006). More than 100,000 thunderstorms occur each year in the U.S., however, only about 10-percent are classified as "severe" (NOAA, 2005). The NWS collected data for thunder days, number and duration of thunder events, and lightening strike density for the 30-year period from 1948 to 1977. A map was produced by the NWS, illustrating thunderstorm hazard severity in the U.S., based on the annual average number of thunder events between 1948 and 1977 (Figure 5.4.1-4) (NVRC, 2006). This figure indicates that Onondaga County experienced between 40 and 50 annual thunder events during this time period.

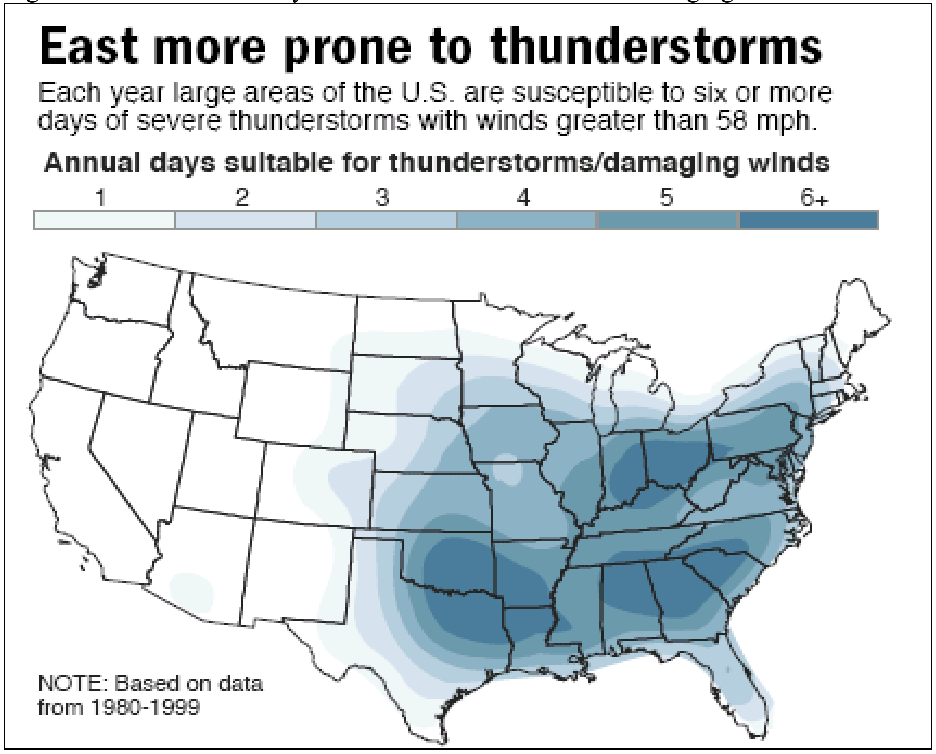
Figure 5.4.1-4. Average Number of Thunderstorms between 1948 and 1977 in the U.S.



Source: NVRC, 2006
Note: The black circle indicates the approximate location of Onondaga County.

NASA scientists suggest that the U.S. will face more severe thunderstorms in the future, with deadly lightning, damaging hail and the potential for tornadoes in the event of climate change (Borenstein, 2007). A recent study conducted by NASA predicts that smaller storm events like thunderstorms will be more dangerous due to climate change (Figure 5.4.1-5). As prepared by the NWS, Figure 5.4.1-5 identifies those areas, particularly within the eastern U.S. that are more prone to thunderstorms, which includes New York State.

Figure 5.4.1-5. Annual Days Suitable for Thunderstorms/Damaging Winds

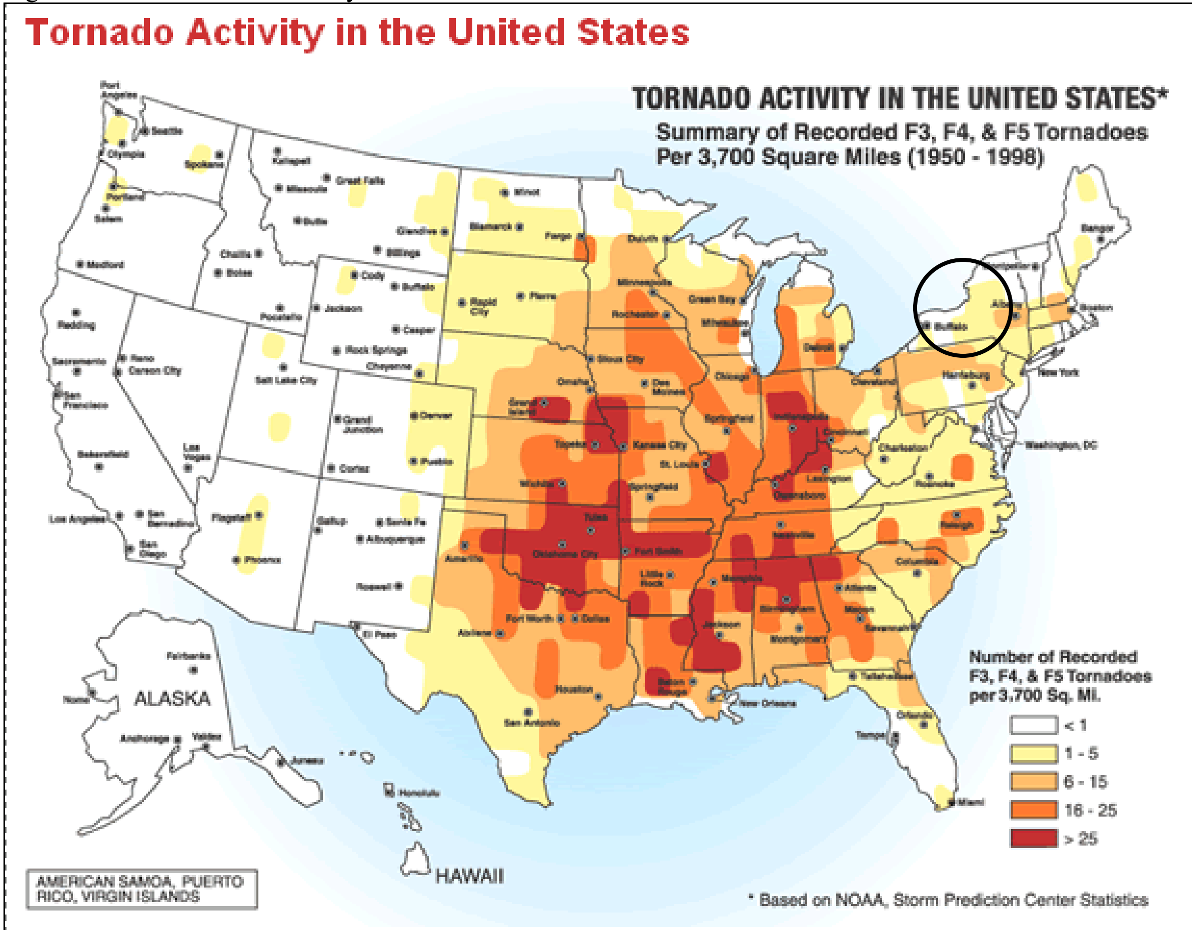


Source: MSNBC.com, 2007

Tornado

According to the NWS, an average of 800 tornadoes affects the U.S. each year. These tornadoes typically result in approximately 80 deaths and over 1,500 injuries annually. The highest concentration of tornadoes in the U.S. has been in Oklahoma, Texas, Kansas, and Florida, as well as the Great Plains region of the central U.S. Tornadoes have also been observed in the central and eastern portions of the U.S (NVRC, 2006). Figure 5.4.1-6 shows tornado activity in the U.S., between 1950 and 1998, based on the number of recorded tornadoes per 3,700 square miles.

Figure 5.4.1-6. Tornado Activity in the U.S.

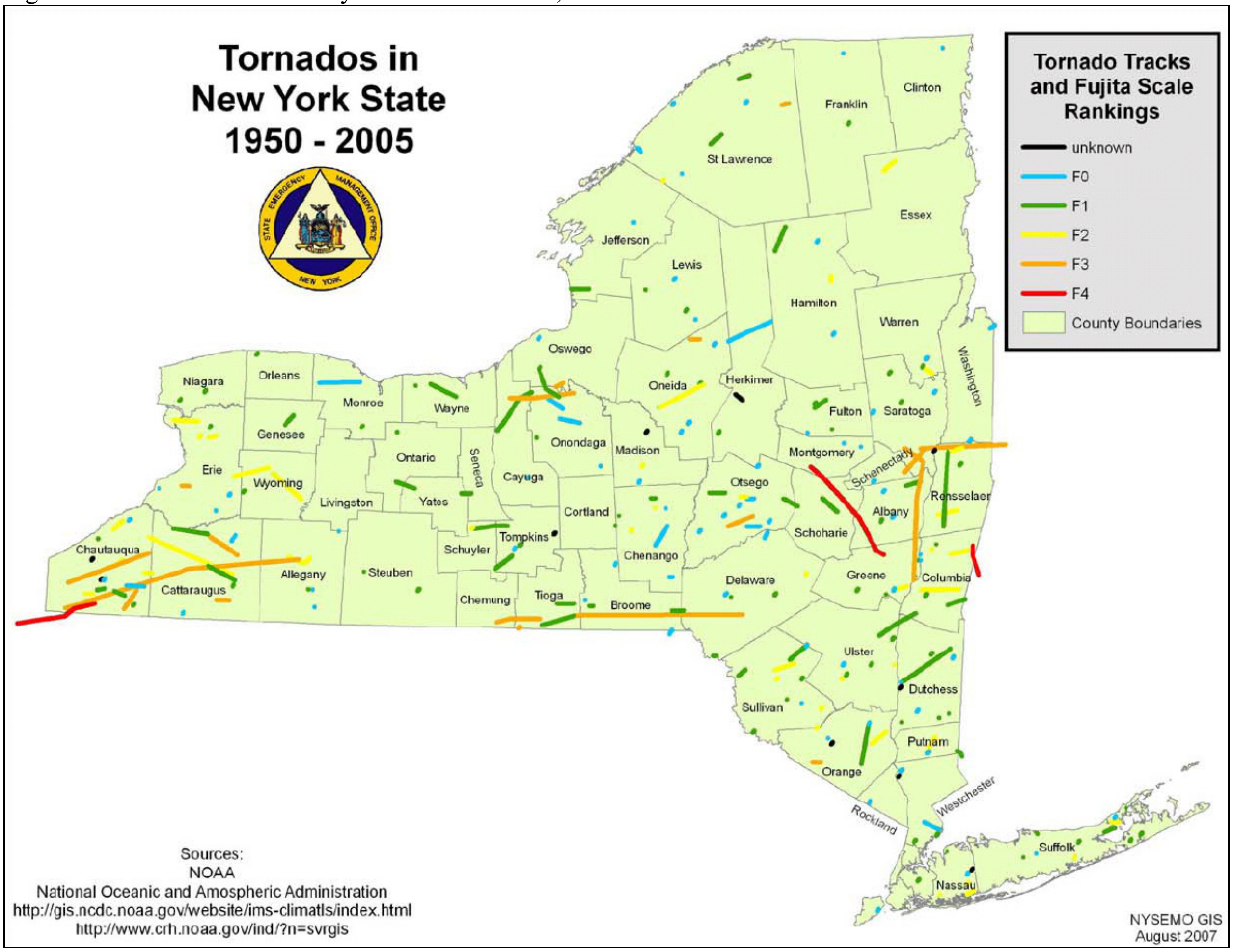


Source: FEMA, 2006

Note: The black circle indicates the approximate location of Onondaga County. Onondaga County experiences between 1 and 15 tornadoes per 3,700 square miles.

New York State ranks 30th in the U.S. for frequency of tornadoes. When compared to other states on the frequency of tornadoes per square mile, New York ranks 35th (The Disaster Center, 2007). New York State has a definite vulnerability to tornadoes and can occur, based on historical occurrences, in any part of the State. According to Figure 5.4.1-7, New York State experiences between 0 and 15 tornadoes per 3,700 square miles and since 1950. The State has experienced 359 tornadoes, ranging from F0 to F4 on the Fujita-Pearson Tornado Intensity Scale. Every county in New York State has experienced a tornado between 1950 and 2007 (NYSDPC, 2008) (Figure 5.4.1-7).

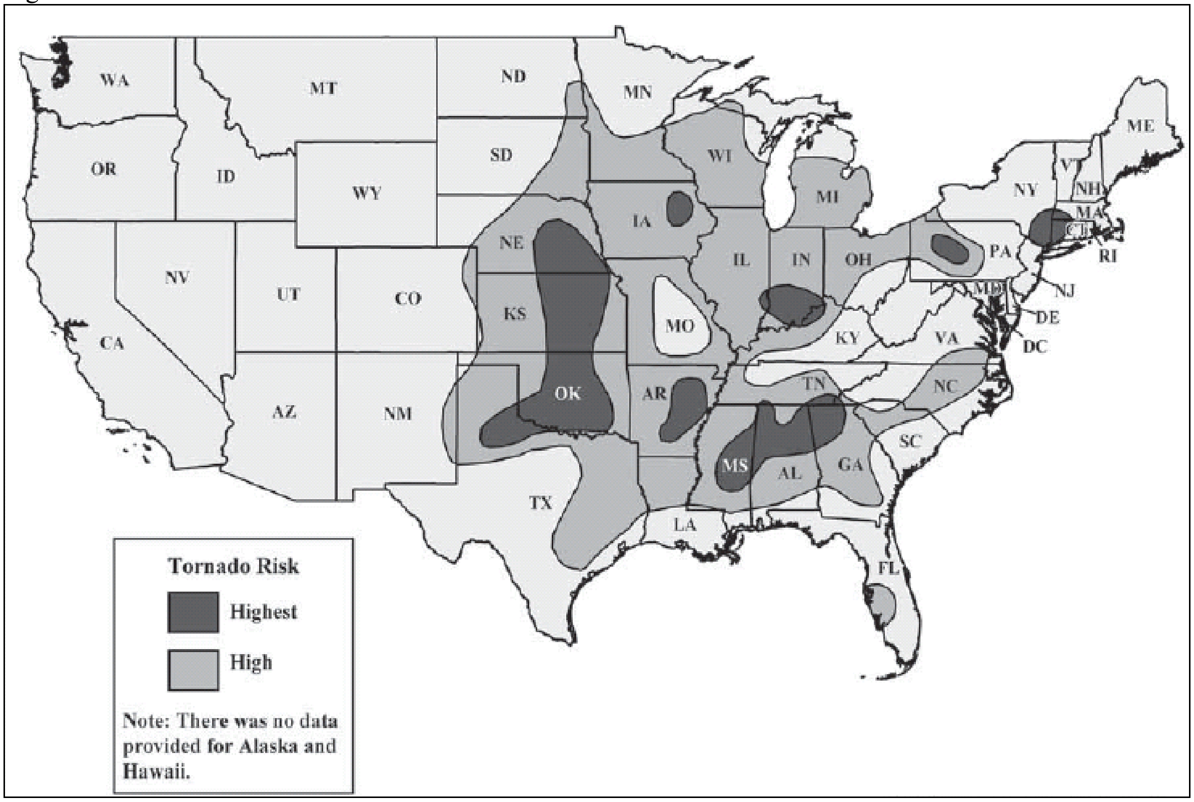
Figure 5.4.1-7. Tornado Activity in New York State, 1950-2005



Source: NYSDPC, 2008

Figure 5.4.1-8 indicates that a majority of the State, with the exception of the southeastern section (Mid-Hudson Region), has an overall low risk of tornado activity, which includes portions of Onondaga County. Details regarding historical tornado events are discussed in the next section (Previous Occurrences and Losses) of this profile.

Figure 5.4.1-8. Tornado Risk in the U.S.

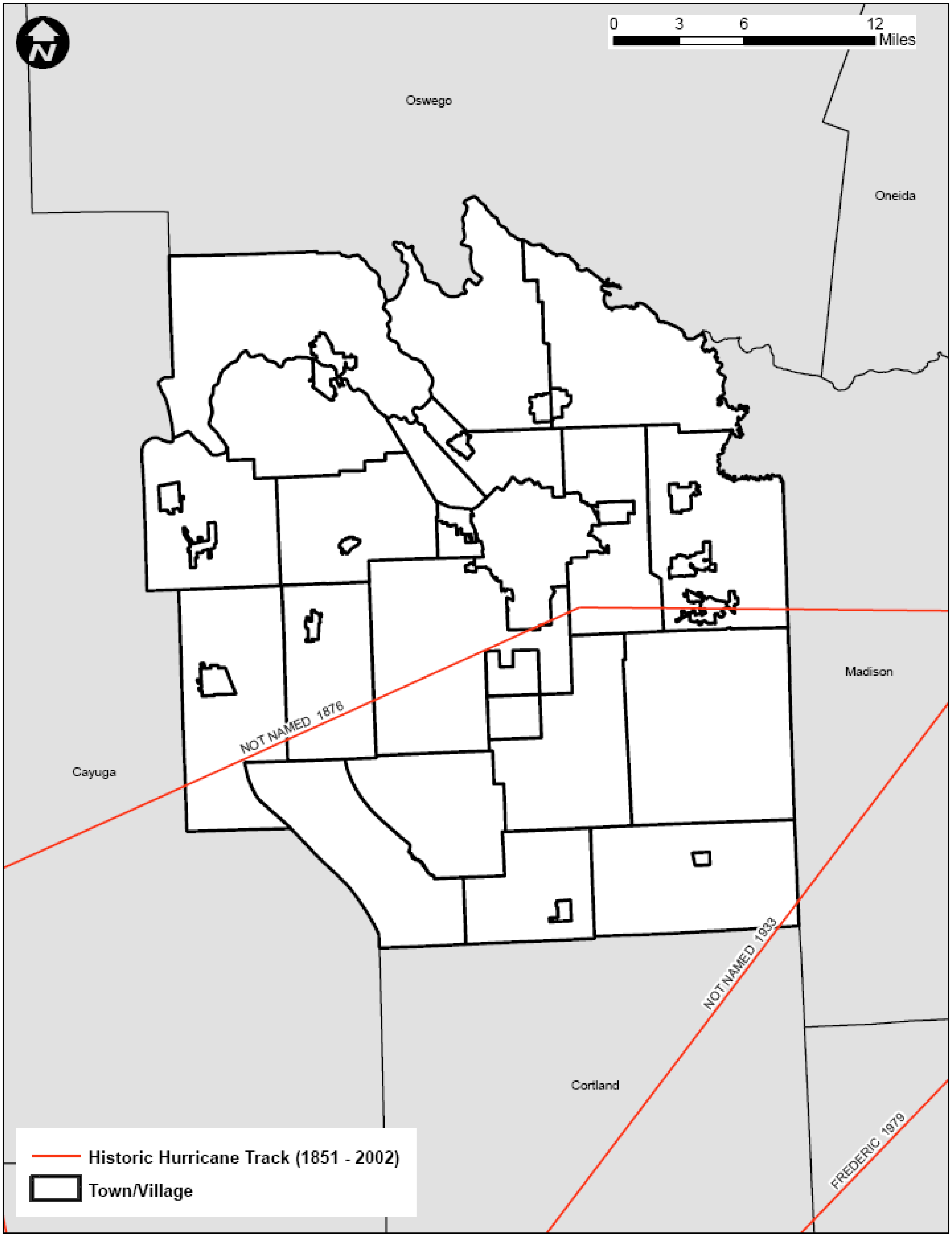


Source: NYSDPC, 2008
Note: Onondaga County is shown has having a low risk of tornado occurrences.

Hurricanes / Tropical Storms

Due to Onondaga County's inland location, hurricanes do not appear to make direct landfall on the mitigation study area. However, the County has been known to experience the indirect landward effects, including high winds, heavy rains, and major flooding associated with hurricane and/or tropical storm events. Hurricanes and tropical storms can impact New York State from June to November, the official eastern U.S. hurricane season. However, late July to early October is the period hurricanes and tropical storms are most likely to impact New York State, due to the coolness of the North Atlantic Ocean waters (NYSDPC, 2008). Figure 5.4.1-9 illustrates the historic hurricane tracks near Onondaga County from 1851 to 2002.

Figure 5.4.1-9. Historic North Atlantic Tropical Cyclone Tracks, 1851-2002



Source: NOAA, 2003

From 1903 to 1989, 24 hurricanes and numerous tropical storms have crossed over New York State. The vast majority of these storms have been over the eastern part of the State, specifically in the southeastern corner. This area includes the New York City metropolitan area and the mid and lower Hudson Valley areas. These areas comprise approximately 61-percent of New York State's population (NYSDPC, 2008).

Multiple sources have indicated that Onondaga County has been impacted by few hurricanes, tropical storms and tropical depressions. The County has felt the direct and indirect landward effects associated with several hurricanes and tropical storms in recent history, such an unnamed tropical storm in 1876, and an unnamed tropical storm in 1933.

The Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool tracks tropical cyclones from 1851 to 2006. Figure 5.4.1-10 displays tropical cyclone tracks for Onondaga County; however, the associated names for some of these events are unknown. Between 1851 and 2007, Onondaga County has experienced 26 tropical cyclone events. These events occurred within 65 nautical miles of the County (NHC, 2006).

Figure 5.4.1-10. Historical North Atlantic Tropical Cyclone Tracks (1851-2006)

Source: NHC, 2008

Note: —— = Tropical Storm
\+ = Extra-tropical

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with severe storms throughout New York State and Onondaga County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary depending on the source.

Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1955 and 2007, FEMA declared that New York experienced 39 severe storm-related disasters classified as one or a combination of the following disaster types: severe storms, hurricane (Ivan-2004, Floyd-1999, Bob-1991, Gloria-1985, Belle-1976, Agnes-1972), coastal storms, flooding, high tides and heavy rain (FEMA, 2007). Of those events, multiple sources, including FEMA, indicated that Onondaga County was declared a disaster area as a result of seven severe storm events. FEMA couples some disasters as severe storms and flooding events; therefore, those severe storm disasters that are also listed as flooding events have been discussed in Section 5.4.3 (Flood) as well. Table 5.4.1-5 summarizes the FEMA Presidential Disaster (DR) or Emergency Declarations (EM) for severe storm events in Onondaga County.

Table 5.4.1-5. Presidential Disaster Declarations for Severe Storm Events in Onondaga County

Type of Event*	Date**	Declaration Number	Cost of Losses (approximate)
Tropical Storm Agnes	July 1972	DR-338	New York State experienced 24 deaths and had approximately $703 M in damages (NYSDPC) as a result of flooding. Onondaga County experienced approximately $1.6 M in property damages and crop damages. For the calendar year of 1972, many rivers and streams within the County experienced record peak streamflows during this flood, particularly along Seneca River, Onondaga Creek, Ninemile Creek and Limestone Creek. This event caused the Onondaga Lake to rise 370.8 feet, causing nearly $150 K in damages to the Town of Salina (which is 40-percent of the estimated $375 K in damages that occurred within the surrounding communities of Onondaga Lake). FIS' for the county indicate that this event created widespread flooding within most jurisdictions of the County.
Severe Storms and Flooding	July 1974	DR-447	The NYSDPC indicates that this is an undeclared event for four counties in New York State; however, FEMA and NYSEMO indicate that it was a declared disaster. Onondaga County experienced approximately $7.2 M in property damages, with $6.5 M in personal property losses (more then any other county impacted by the event). Most of these damages were a result of flooding throughout the County. Many rivers and streams within Onondaga County experienced peak streamflows and flooding during this event, particularly along Harbor Brook, Onondaga Creek, Butternut Creek and Limestone Creek. Floodwaters resulted in the evacuation of many homes and the flooding of houses, roads and underpasses throughout most of the County.
Severe Storms, Heavy Rain, Landslides, Flooding	September 1975	DR-487	Remnant flooding occurred in New York State as a result of Hurricane Eloise. Losses in New York State are unknown; however, it is reported that Onondaga County experienced approximately $6.3 M in property damages. Rain totals during this event within the vicinity of Onondaga County totaled between 3 and 5 inches. For the year of 1975, peak streamflows occurred along Ley Creek in Syracuse during this event.

Type of Event*	Date**	Declaration Number	Cost of Losses (approximate)
Severe Storms and Flooding	January 1996	DR-1095	New York State experienced between $100 and $160 M in eligible damages, road closures, closed businesses, and 10 deaths (NYSDPC). New York State received $16.7 M in individual assistance and $103.7 M in public assistance. Onondaga County experienced approximately $7.6 M in flood damages. USGS indicated through information provided by FEMA that Onondaga County received approximately $1.1 M in public assistance (1997 USD).
Severe Storms	September 1998	DR-1244	Multiple New York State Counties suffered extensive damage during this 'Derecho' event. Towns in Onondaga County experienced approximately $90 M in property damages, 3 fatalities and 7 injuries. Thousands of trees were toppled throughout the County, heavy damage occurred at the New York State Fairgrounds in Geddes; many permanent buildings had roofs torn off, windows blown out, or siding severely damaged from felled trees; most roadways were rendered completely impassable from downed trees and live wires.
Severe Storms	May - September 2000	DR-1335	New York State experienced approximately $34.6 M in eligible damages (NYSDPC). Losses in Onondaga County are unknown. Heavy rains caused significant ponding of water on streets in Syracuse, Manlius, and Fayetteville.
Severe Storms and Flooding	August – September 2004	DR-1564	New York State experienced approximately $18.03 M in eligible damages (NYSDPC). Onondaga County experienced approximately $2.0 M in flood damages. Most of the damages were a result of flooding throughout the County. Rainfall totals in Onondaga County ranged between 2.2 inches in Camillus and 4.87 inches in Tully. As of December 10, 2004, more than $1.8 M in disaster aid has been approved for the State. Disaster aid for Onondaga County is unknown.

Source(s): FEMA, 2008; NYSDPC, 2008; Hazards & Vulnerability Research Institute (SHELDUS), 2008; NCDC, 2008; NYSEMO, 2006

* The 'Type of Event' is the disaster classification that was assigned to the event by FEMA.

** Represents the date of the event

Note (1): Dollars rounded to nearest thousand. Recorded losses indicate the dollar value of covered losses paid, as available through the public records reviewed. Some of these events overlap with events shown under the Flood and Severe Winter Storm hazard profiles of this Plan.

K = Thousands ($)

M = Millions ($)

USD = U.S. Dollars

Based on all sources researched, many notable severe storm events have impacted Onondaga County. All other severe storm events are identified in Table 5.4.1-6 below; however, severe storm documentation for New York is extensive and, therefore, not all sources may have been identified or researched. Hence, Table 5.4.1-6 may not include all events that have occurred throughout the region.

Table 5.4.1-6. Severe Storm Events between 1871 and 2007

Event Name / Date	Location	Losses / Impacts	Source(s)
TSTM / Lightning July 9, 1871	Syracuse and Geddes	Two severe storms passed over Syracuse within a few hours of each other. The wind was so violent that it blew down numerous trees. A building was blown down and the high school in Geddes and several barns were unroofed. Lightning struck in every party of Syracuse. The lightning set fire to two private dwellings. During the storm, walnut-sized hailstones fell, causing great damage to crops in the area. One person was struck by lightning and killed.	New York Times
Hailstorm August 31, 1885	Multi-County	Severe hailstorm hit the southern part of Oswego County and the northern part of Onondaga County. Marble-sized hailstones fell and a large quantity of tobacco was damaged.	New York Times
Tornado December 26, 1889	Syracuse	A tornado from the southwest swept over Onondaga Lake, damaging many buildings. The roof of the People's Street Railway Company was blown off and the front walls of the building came down. Large amount of damage was done to the building. One death and three injuries were reported. Building damage was estimated around several thousand dollars.	New York Times
Tornado (F0) June 11, 1963	Countywide	A F0 tornado extended through the County for 5 miles, resulting in $2.5 K in property damages.	NOAA-NCDC
Remnants of Hurricane Agnes June 20-25, 1972 (FEMA DR-338)	Multi-State	See FEMA Disaster Declarations (Table 5.4.1-5)	FEMA, Hazards & Vulnerability Research Institute (SHELDUS), NYSEMO History of Declarations, USGS, NYSDEPC, USACE, NWS
Severe Storms and Flooding July 3-5, 1974 (FEMA DR-447)	Multi-County	See FEMA Disaster Declarations (Table 5.4.1-5)	FEMA, NYSEMO, Endreny and Hassett, NYSC
Severe Storms, Heavy Rain, Landslides,	Multi-State	See FEMA Disaster Declarations (Table 5.4.1-5)	FEMA, HPC, USGS, NYSEMO, Perry et al.

Event Name / Date	Location	Losses / Impacts	Source(s)
Flooding September 22-27, 1975 (FEMA DR-487) (Remnants of Hurricane Eloise)			
Tornado (F3) May 2, 1983	Countywide	An F3 tornado extended through the County for 14 miles, resulting in $2.5 M in property damages.	NOAA-NCDC
Tornado (F1) July 13, 1986	Countywide	An F1 tornado extended through the County for 4 miles, resulting in $250 K in property damages.	NOAA-NCDC
TSTM / Winds October 15, 1989	Countywide	Toppled trees caused many county residents to lose power. At least 1,000 Syracuse customers lost power when the storm hit.	NY Times
Tornado (F0) August 28, 1990	Countywide	An F0 tornado extended through the County for 6 miles, resulting in $25 K in property damages.	NOAA-NCDC
TSTM / Wind May 5, 1993	Syracuse	Winds downed power lines and trees; ¾-inch hail fell at Silver Lake. Experienced approximately $50 K in property damage.	NOAA-NCDC
TSTM / Wind August 2, 1993	Countywide	TSTMs produced golf-ball sized hail and strong winds downed many trees and power lines. Hardest hit area was East Syracuse. Experienced approximately $600 K in property damage.	NOAA-NCDC
Tornado (F0) August 24, 1993	Syracuse	An F1 tornado extended through Syracuse resulting in $500 K in property damages.	NOAA-NCDC
Hail July 2, 1994	Countywide	1.75 inch hail was reported in Baldwinsville and Cicero. LaFayette had 0.75 inch hail. Experienced approximately $60 K in property damage and $5 K in crop damage.	NOAA-NCDC
TSTM / Winds August 28, 1994	Clay	Experienced approximately $50 K in property damage.	NOAA-NCDC
High Winds November 11, 1995	Multi-County	A cold front coming from the Great Lakes brought high winds to much of the western Southern Tier and central New York State. Winds gusted to 44 mph at Hancock International Airport in Syracuse. The high winds downed trees and power lines, resulting in widespread power outages. Overall, Onondaga County had approximately $15 K in property damage from winter weather, with approximately $2 K in property damage from high winds.	NOAA-NCDC, Hazards & Vulnerability Research Institute (SHELDUS)
Severe Storms and Flood January 18-20, 1996	Northeastern U.S.	See FEMA Disaster Declarations (Table 5.4.1-5)	FEMA, NOAA-NCDC, NYSDPC , NWS, Lumia

Event Name / Date	Location	Losses / Impacts	Source(s)
(FEMA DR-1095) "Deluge of 1996"			(USGS WRIR 97-4252), Hazards & Vulnerability Research Institute (SHELDUS), NYSEMO, USGS
TSTM / Winds January 27, 1996	Multi-County	Syracuse experienced 54 mph winds. Counties affected experienced approximately $133 K in property damages.	NOAA-NCDC
TSTM / Winds February 24-25, 1996	Multi-County	With downed trees and power lines, 20,000 customers from Syracuse to Utica were left without power. Counties affected experienced approximately $150 K in property damages.	NOAA-NCDC
TSTM / Wind July 19, 1996	Countywide (Cicero)	Severe TSTM snapped off large tree limbs and caused structural damage in northern Onondaga County. Several roofs were blown off storage sheds, road signs were bent, and a 9,000-pound trailer was blown on its side. Approximately $15 K in property damage.	NOAA-NCDC, Hazards & Vulnerability Research Institute (SHELDUS)
TSTM / Hail / Wind July 15, 1996	Countywide (Liverpool and Baldwinsville)	TSTM hit moved across northern Onondaga County, producing downburst winds that blew down large trees in Liverpool. Widespread damage was seen in Baldwinsville where several large trees were uprooted and utility poles were knocked down across several roadways. Approximately $30 K in property damage.	NOAA-NCDC, Hazards & Vulnerability Research Institute (SHELDUS)
TSTM / Wind May 29, 1998	Cicero to Manlius	Numerous trees and wires were downed across northern and eastern sections of the Syracuse metropolitan area. One man in Cicero was injured when he was shocked from falling wires. In Syracuse, another man was struck and killed by a large tree limb on the corner of Congress and Holland Streets. Many large trees and power lines littered streets in northern and eastern portions of the Syracuse metropolitan area in the wake of the thunderstorms. Towns affected experienced approximately $40 K in property damages.	NOAA-NCDC
TSTM / Hail / Tornado May 31, 1998 "Tornado Outbreak"	Multi-County	Several lines of severe TSTMs formed in eastern New York State. The series of storms resulted in 6 separate tornadoes and storm damage in every county. Widespread power outages occurred throughout eastern New York State. Strong winds downed power lines, power poles and trees. Some counties were declared disaster areas by Governor Pataki. In Onondaga County, the storms blew down transmission towers in Nedrow and downed many	NWS, NOAA-NCDC, Hazards & Vulnerability Research Institute (SHELDUS)

Event Name / Date	Location	Losses / Impacts	Source(s)
		trees and power lines. Dime size hail in Camillus and Manlius. Wind gusts were estimated at 90 to 100 mph. Experienced approximately $200 K in property damage in the County.	
TSTM / Winds August 24, 1998	Countywide	Dime sized hail reported in the town of Clay. Wind gusts up to 70 mph caused several downed trees and power lines in Manlius. In the town of Lysander, several trees were toppled and/or uprooted. Two trees reportedly fell upon a parked vehicle and caused extensive damage. In Van Buren Township, the roof was blown off of a barn. Three adjacent silos were also heavily damaged. From northern sections of Syracuse straight across to Manlius, dozens of trees were blown down. Several roads had to be closed until crews could clear fallen debris and repair damaged traffic signals. In Manlius, two trees and a utility pole were toppled onto a house. Heavy damage was sustained in the home's front porch and garage areas. Towns affected experienced approximately $200 K in property damages.	NOAA-NCDC
TSTM / Winds September 7, 1998 (FEMA DR-1244)	Baldwinsville to Manlius	See FEMA Disaster Declarations (Table 5.4.1-5)	NOAA-NCDC, Audet, SPC, Hazards & Vulnerability Research Institute (SHELDUS), Onondaga County
TSTM / Winds November 10, 1998	Multi-County	The strongest winds affected sections of northern Onondaga County north and west of Syracuse. In Lysander and Baldwinsville, emergency management officials reported that several trees blocked roadways for a time and 10,000 to 15,000 customers were without power. Counties affected experienced approximately $145 K in property damages.	NOAA-NCDC
TSTM / Winds July 3, 1999	Countywide	Numerous trees and powerlines blown down throughout the county with power outages reported in Syracuse, Liverpool, Lakeport, Manlius, Fayetteville and Tully. A few homes received minor damage from fallen trees and limbs in several of these towns. Numerous tents and booths were blown down at the "Taste of Syracuse" festival in the city of Syracuse. Eleven people sustained minor injuries from flying debris at this location. Several boats were overturned in Owasco Lake and a 4 year old girl drowned	NOAA-NCDC

Event Name / Date	Location	Losses / Impacts	Source(s)
		underneath a capsized pontoon boat. Towns affected experienced approximately $750 K in property damages.	
Tornado (F0) September 24, 2001	Countywide	An F0 tornado extended through Fabius for 1 mile, resulting in $1 K in property damages. The initial touchdown occurred at the intersection of Goodrich Road and Route 80. Spotty damage was observed along a 1/2 mile long, 75 yard wide path. Most of the damage was concentrated at a residence near the initial touchdown where several large trees were downed and a small shed was destroyed. Maximum sustained winds were estimated at 50 to 70 mph.	NOAA-NCDC
Severe Storms May 3, – September, 14, 2000 (FEMA DR-1335)	Statewide	See FEMA Disaster Declarations (Table 5.4.1-5)	Chittenden, FEMA, NYSDPC, NOAA-NCDC, Hazards & Vulnerability Research Institute (SHELDUS), NYSEMO
TSTM / Winds February 10, 2001	Multi-County	High winds with the fast moving front knocked down numerous trees and power lines. 75 mph winds were reported in East Syracuse. Counties affected experienced approximately $150 K in property damages.	NOAA-NCDC
Lightning June 15, 2002	Syracuse	Lightning struck the roof and chimney of a three story apartment building. Bricks flew as far as 100 feet. These flying bricks broke building and car windows across the street at Hiawatha Used Cars, bore holes in the roof of another building, and dented the siding of Tucci Furniture across the street. The lightning knocked out a window and partially collapsed a ceiling on the third floor. The seven families in the building had to find somewhere else to stay until the building was repaired. The Town experienced approximately $20 K in property damages.	NOAA-NCDC
TSTM / Wind / Tornado (F1) July 28, 2002	Skaneateles (Mottville)	A F1 tornado touched down briefly in the hamlet of Mottville of Skaneateles, resulting in over $2 M in damages. A trailer home was destroyed in the center of Mottville. Several large trees were sheared off 10 to 20 feet above the ground. Falling trees damaged several homes and businesses in the area. The Mottville post office had two large pine trees lying on the roof. The storm continued south into the center of the village of Skaneateles. Damage in this area was due to straight line winds. More than 3,000	NOAA-NCDC

Event Name / Date	Location	Losses / Impacts	Source(s)
		customers lost electricity. There were no deaths or serious injuries caused by the tornado. A state of emergency was declared in the town of Skaneateles.	
Lightning August 23, 2002	Syracuse	A small commuter plane from the Hancock Syracuse Airport was struck by lightning, causing the plane to make an emergency landing. No passengers were injured.	The Post Standard (Syracuse)
Lightning March 21, 2003	Manlius	A lightning strike tripped a circuit breaker knocking out power to 1,000 electric customers in Fayetteville and Minoa, both in the town of Manlius. The Town experienced approximately $50 K in property damages.	NOAA-NCDC, The Post Standard
Severe Storm / Flooding / Lightning May 23-24, 2004	Solvay	3-inch diameter hail fell in Solvay. Approximately $110 K in property damage due to lightning, hail and flooding ($90 K from lightning and hail). In Syracuse, lightning struck the police headquarters on 550 South State Street blowing out the department's computer system. Also, lightning struck a vacant house at 201 Elliott Street in Syracuse.	NOAA-NCDC, Hazards & Vulnerability Research Institute (SHELDUS), The Post Standard
Severe Storms August 13 – September 16, 2004 (FEMA DR-1564)	Multi-County	See FEMA Disaster Declarations (Table 5.4.1-5)	FEMA, NYSEMO, NWS, Hazards & Vulnerability Research Institute (SHELDUS), NOAA-NCDC
Lightning / TSTM August 27, 2004	Lyncourt	A 12 year old boy in Lyncourt was killed by lightning after taking shelter under a tree. A half inch of rain fell at Syracuse Hancock Airport. Many power outages were reported throughout the County.	The Post Standard
Lightning August 28, 2004	Baldwinsville	Lightning struck a substation knocking out power to 8,000 residents in the area and causing approximately $20 K in property damages.	NOAA-NCDC, The Post Standard
Lightning August 29, 2004	Pompey	Lightning started a fire destroying a detached two car garage on Henneberry Road in Pompey, resulting in over $100 K in property damage.	NOAA-NCDC, The Post Standard
Winds October 15, 2004	Multi-County	In Cicero, high winds caused a tree to fall on a car, injuring the occupant. Counties affected experienced approximately $1 M in property damages.	NOAA-NCDC
Severe Storms and Flood April 2-4, 2005	Multi-State	Resulted in a Disaster Declaration for 20 New York State counties (DR-1589), however, it did not include Onondaga County. New York State experienced approximately $66.2 M in eligible damages (NYSDPC). The County experienced approximately $100 K in property damages. There were	NCDC, NWS, FEMA, NYSDPC, NOAA-NCDC, Hazards & Vulnerability Research Institute (SHELDUS), NYSEMO,

Event Name / Date	Location	Losses / Impacts	Source(s)
		some road closures and flooded basements in DeWitt, East Syracuse, Manlius, and Lafayette.	AHPS, USGS
Lightning August 8, 2005	Manlius	Lightning struck an apartment complex deck in Manlius starting a fire. The fire spread to another apartment building that was attached. No injuries were reported. Approximate damages totaled $50 K.	NOAA-NCDC, The Post Standard
TSTM July 9, 2005	Baldwinsville	Over 2,000 residents in Baldwinsville were without power as a result of a fallen tree limb during the storm.	The Post Standard
Lightning Storm July 14, 2005	Syracuse	A lightning storm dumped a record 2.24 inches of rain on Syracuse, knocking out power to 38,000 residents and flooding streets and parking lots. There were no reported injuries.	The Post Standard
TSTM / Winds November 6, 2005	Cicero to East Syracuse	Thunderstorm winds uprooted trees in East Syracuse. Winds also downed several trees and partially destroyed a fence in Cicero. A tree fell on a parked car also in Cicero. Winds also blew down several trees in Mattydale. Towns affected experienced approximately $20 K in property damages.	NOAA-NCDC
High Winds February 17, 2006	Multi-County	Some of the more notable damage included a roof ripped off a carpet store in Onondaga County. Over 200,000 residents of north central New York were without power during the height of the storm. Some residents did not get their power restored for over one week. Counties affected experienced approximately $100 K in property damages.	NOAA-NCDC
Severe Storms and Flood June 25 - July 12, 2006	Multi-State	This event was the largest and most costly natural disaster that New York State has encountered since Hurricane Agnes hit the State in 1972. Resulted in a Disaster Declaration for 19 New York State counties (DR-1650), however, it did not include Onondaga County. New York State experienced approximately $246.3 M in eligible damages (NYSDPC). Onondaga County experienced approximately $29 K in property damages. Most of the damages were a result of flooding throughout the County. Although Onondaga County was not declared as an official disaster area under this declaration, all counties of the State were eligible to apply for federal assistance under the Hazard Mitigation Grant Program. As of December 29, 2006, more than $227 M in disaster aid was approved for the State. Disaster aid in Onondaga County is unknown.	FEMA, NOAA-NCDC, NWS, NYSEMO, NYSDPC, USGS, NOAA, Lanza, USGS, Goldberg and Greene (The Post Standard), Doherty (The Post Standard), Weiner, Baker

Event Name / Date	Location	Losses / Impacts	Source(s)
		The storm overwhelmed county sewer systems, causing raw sewage to seep in Onondaga Lake after the Metropolitan Sewage Treatment Plant exceeded its capacity. A tornado spawned, cutting a three-mile swath from Marcellus to Onondaga, with the heaviest amount of damage reported in Cicero. On July 12th, 4.29 inches of rain was measured at Syracuse's Hancock Airport, making it the wettest day since record-keeping began at the airport in 1949.	
Tornado (F0) July 29, 2006	Marcellus	A F0 tornado touched down in the Village of Marcellus, resulting in over $10 K in property damages. Damage was largely to trees which were uprooted and snapped. A portion of a tin roof on a residence was pulled off the building and flipped to the other side. A definitive, convergent damage path was noted on the east side of the village in the Orchard Street and Kinderwood Road areas with scattered damage heading southeast out of town. An eyewitness observed a tornado pass just to the east of Marcellus Park, then track approximately 3 miles to the southeast before going out of view. Additional damage was noted in the vicinity of South Onondaga, including utility poles and power lines on Nichols and Hutchings Roads.	NOAA-NCDC, NWS

Note (1): The intensity of tornado events to affect Onondaga County is measured by the Fujita Scale in this Table, which was decommissioned on February 2007. NOAA-NCDC storm query indicated that Onondaga County has experienced 304 severe storm events between January 1, 1950 and May 31, 2008 (including Thunderstorm, Hail, Wind, Hurricane, Lightning, and Tornado events). However, not all of these events were identified in this table due to a lack of detail and/or their minor impact upon the County.

Note (2): Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of inflation.

* According to many sources, these events were known as Nor'easters, therefore, they are not discussed further in this hazard profile and are further mentioned in Section 5.4.2 (Severe Winter Storm) and the flooding impact of the events are mentioned in Section 5.4.3 (Flood)

DR	Federal Disaster Declaration	NWS	National Weather Service
EM	Federal Emergency Declaration	NYS DPC	New York State Disaster Preparedness Commission
F	Fujita Scale (F0 – F5)	NYSEMO	New York State Emergency Management Office
FEMA	Federal Emergency Management Agency	NRCC	Northeast Regional Climate Center
HMP	Hazard Mitigation Plan	OEM	Office of Emergency Management
HPC	Hydrometeorological Prediction Center	SHELDUS	Spatial Hazard Events and Losses Database for the U.S.
K	Thousand ($)	SPC	Storm Prediction Center (NOAA)
M	Million ($)	TSTM	Thunderstorm
mph	Miles Per Hour	U.S.	United States
NCDC	National Climate Data Center	USGS	U.S. Geological Survey
NOAA	National Oceanic Atmospheric Administration		

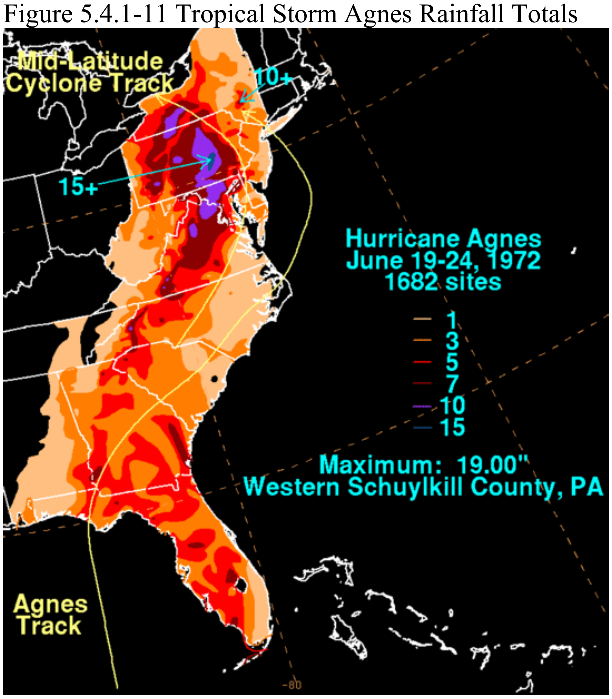
Further descriptions of select severe storm events that have impacted Onondaga County are provided in below with details regarding their impact (where available). These descriptions are provided to give the reader a context of the severe storm events that have affected the County and to assist local officials in locating event-specific data for their municipalities based on the time and proximity of these events. Many severe storm events resulted in major flooding throughout the County; therefore, the flood impacts of these events are further mentioned in more detail in Section 5.4.3 (Flood). Certain severe storm events that have been classified as Nor'Easters are further included in Section 5.4.2 (Severe Winter Storm).

Monetary figures within the following event descriptions were U.S. Dollar (USD) figures calculated during or within the approximate time of the event (unless present day recalculations were made by the sources reviewed). If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of increased inflation.

June 20-25, 1972 (Remnants of Tropical Storm Agnes) (FEMA DR-338): Tropical Storm Agnes dropped as much as 19 inches of rain as it left the Gulf of Mexico as a hurricane. Agnes downgraded to a tropical storm as it hit every state from Florida to New York State (Figure 5.4.1-11). More than 210,000 people were forced to evacuate their homes. The storm broke long-standing flood records in six states, resulting in $3.2 billion in property damage and 122 fatalities. Tropical Storm Agnes remained the most costly disaster until Hurricane Andrew (1992). Pennsylvania and New York State experienced the greatest rainfall totals and suffered the most losses from this storm (NOAA, 1997; USACE, 1973). New York State experienced 24 deaths and approximately $703 million in damages as a result of flooding from this storm (NYSDPC, 2008; Middle Atlantic River Forecast Center [MARFC], 2006).

In Onondaga County, this event was documented as one of the major flood events of the County, experiencing approximately $1.6 million in property and crop damages (Hazards & Vulnerability Research Institute, 2007). Flood impacts within New York State and Onondaga County are further mentioned in Section 5.4.3 (Flood).

Figure 5.4.1-11 Tropical Storm Agnes Rainfall Totals



Source: Roth, Date Unknown

This storm resulted in a FEMA Disaster Declaration (FEMA DR-338) for New York State on June 23, 1972. Through this declaration, the following 26 counties were declared eligible for Federal and State disaster funds: Allegany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Livingston, Madison, Monroe, Oneida, Onondaga, Ontario, Orange, Oswego, Rockland, Schuyler, Seneca, Steuben, Tioga, Tompkins, Ulster, Wayne, Westchester, Wyoming, Yates (NYSEMO, 2006; FEMA, 2008; NYSDPC, 2008). Disaster assistance for all counties affected in the State was not disclosed in the materials reviewed to develop this plan.

July 3-5, 1974 (FEMA DR-447): A wide region of central and eastern New York State suffered from a storm system moving northward across the State, causing showers and thunderstorms in the Oswego-Syracuse-Cobleskill region. Precipitation totals ranged between 3.8 and 5.0 inches throughout the State. The City of Syracuse experienced over 4.5 inches of rain (Robison et al., 1976).

In New York State, Governor Wilson declared seven counties a major disaster area, including Chenango, Herkimer, Onieda, Onondaga, Oswego, Otsego and Schoharie Counties. The Governor applied to the Federal Government for financial aid under provisions of U.S. Public Law 93-228. Preliminary estimates of overall damage in New York State to private property, public property, and agricultural land and crops, as used in the application for aid, was approximately $12.6 million (Robison et al., 1976).

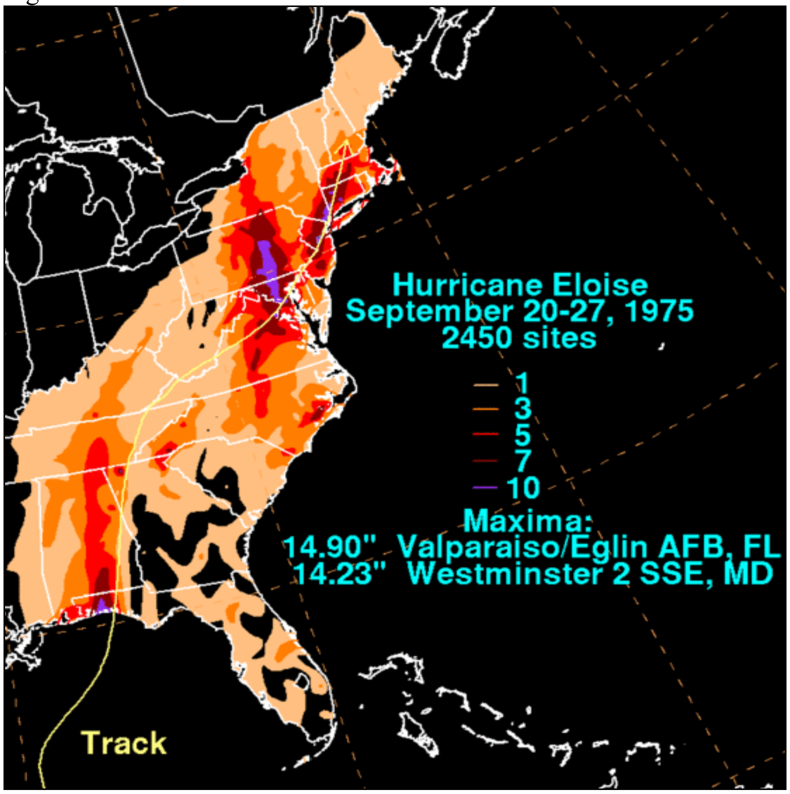
Onondaga County experienced the most damage over any other county in the State, estimated at $7.2 million. The County suffered $6.5 million in damages to private property; $500,000 to public property; and $200,000 to agricultural land (Robison et al., 1976). Flood impacts within New York State and Onondaga County are further mentioned in Section 5.4.3 (Flood).

This storm resulted in a FEMA Disaster Declaration (FEMA DR-447) for New York State on July 23, 1974. Through this declaration, the following 4 counties were declared eligible for Federal and State disaster funds: Herkimer, Oneida, Onondaga, Oswego (NYSEMO, 2006; FEMA, 2008; NYSDPC, 2008). Disaster assistance for all counties affected in the State was not disclosed in the materials reviewed to develop this plan.

September 22-27, 1975 (Remnants of Hurricane Eloise) (FEMA DR-487): Hurricane Eloise caused flooding throughout the eastern U.S and in Puerto Rico. This storm made landfall in southeastern Louisiana and then followed a northeasterly path from Mississippi and Alabama and further along the East Coast, up through New York State (Figure 5.4.1-12). Total storm damages were estimated at $415 million. Counties in New York, Pennsylvania, Maryland, Florida, and Alabama were declared disaster areas (Perry et al., 2005).

Total losses in New York State are unknown; however, it was reported that Onondaga County experienced approximately $6.3 million in property damages from this event (Hazards & Vulnerability Research Institute, 2007). Rain totals within the vicinity of Onondaga County totaled between 3 and 5 inches (Roth, 2006). Flood impacts within New York State and Onondaga County are further mentioned in Section 5.4.3 (Flood).

Figure 5.4.1-12 Hurricane Eloise Rainfall Totals



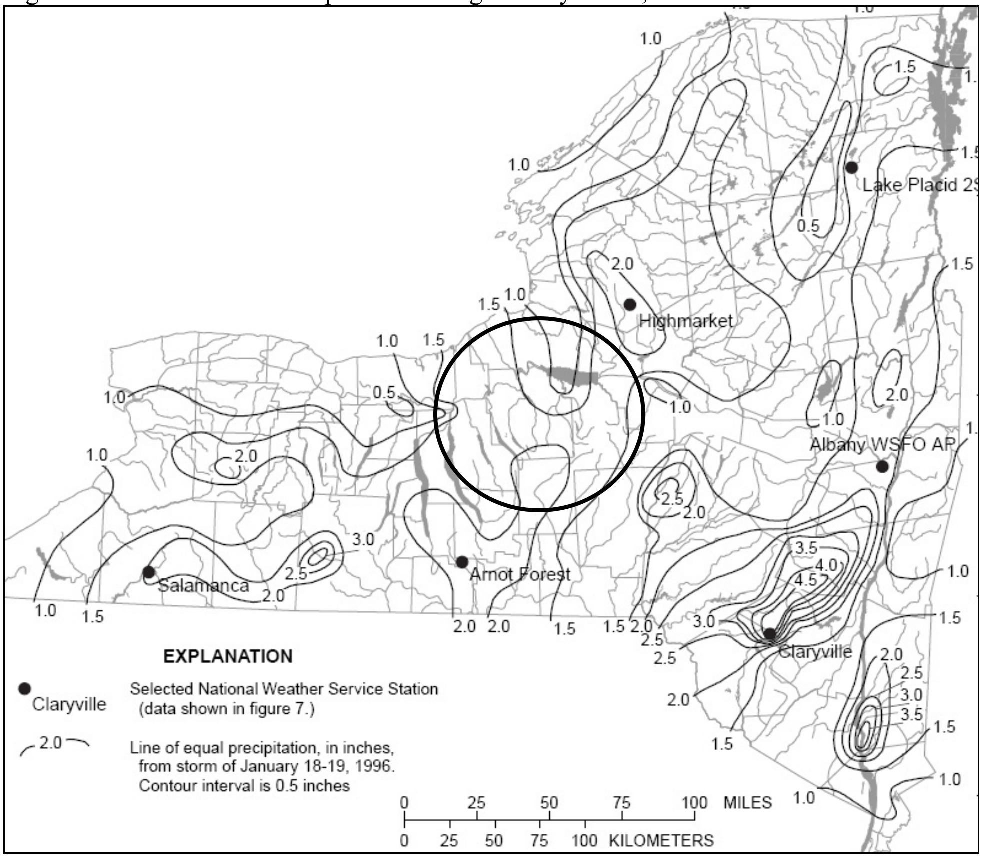
Source: Roth, 2006

This storm resulted in a FEMA Disaster Declaration (FEMA DR-487) for New York State on October 2, 1975. Through this declaration, the following 17 counties were declared eligible for Federal and State disaster funds: Allegany, Broome, Cayuga, Chemung, Cortland, Madison, Onondaga, Oswego, Putnam, Queens, Richmond, Rockland, Steuben, Tioga, Tompkins, Westchester, Yates (NYSEMO, 2006; FEMA, 2008; NYSDPC, 2008). Disaster assistance for all counties affected in the State was not disclosed in the materials reviewed to develop this plan.

January 18-20, 1996 (FEMA DR-1095): A strong storm produced significant precipitation between January 18th and 20th. Combined with unseasonably warm temperatures, causing rapid snowmelt, extensive flooding occurred throughout New York State. The storm and flooding claimed ten lives, stranded hundreds of people, destroyed or damaged thousands of homes and businesses, and closed hundreds of roads. The areas within and surrounding the Catskill Mountains were severely affected by this event. More than 4.5 inches of rain fell on at least 45 inches of melting snow in the Catskill Mountain region and caused major flooding throughout the southeastern section of the State (Figure 5.4.1-13). New York State experienced between \$100 and \$160 million in property damages from this event (Lumia, 1998; NYSDPC, 2008).

Onondaga County experienced approximately \$7.6 million in flood damages from this event (NCDC, 2008; Hazards & Vulnerability Research Institute, 2007). Flood impacts within New York State and Onondaga County are further mentioned in Section 5.4.3 (Flood).

Figure 5.4.1-13 Lines of Precipitation during January 18-19, 1996

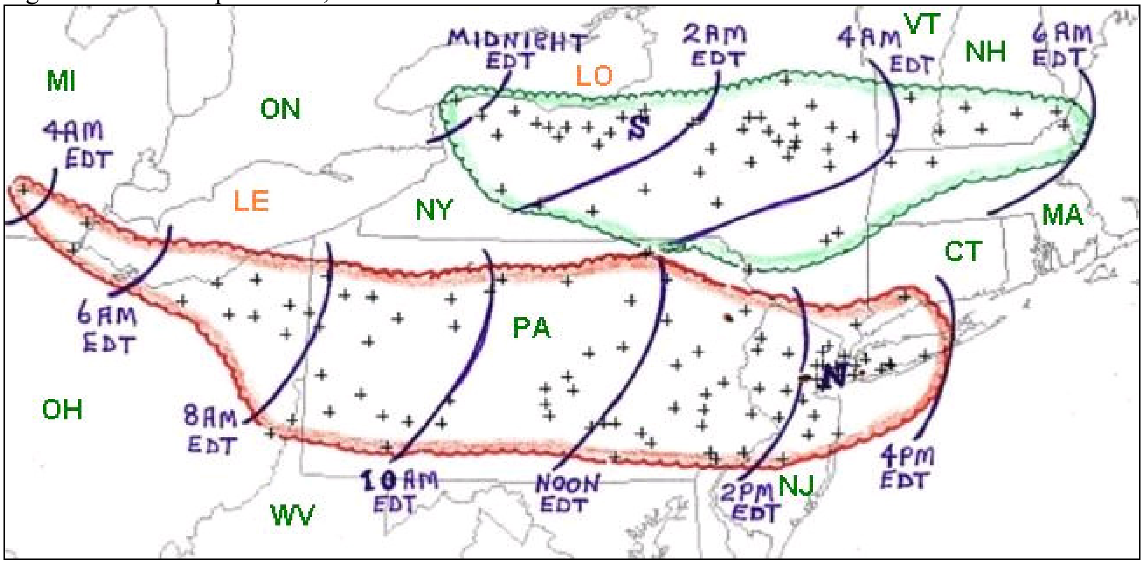


Source: Lumia, 1998 (Data from NOAA, 1996).
Note: The black circle within New York State indicates the approximate location of Onondaga County

This storm resulted in a FEMA Disaster Declaration (FEMA DR-1095) on January 24, 1996. Through this declaration, the following 41 counties were declared eligible for Federal and State disaster funds: Albany, Allegany, Broome, Cattaraugus, Cayuga, Chemung, Chenango, Clinton, Columbia, Cortland, Delaware, Dutchess, Essex, Franklin, Greene, Herkimer, Jefferson, Lewis, Livingston, Madison, Montgomery, Onondaga, Ontario, Orange, Otsego, Putnam, Rensselaer, St. Lawrence, Saratoga, Schenectady, Schoharie, Schuyler, Steuben, Sullivan, Tioga, Tompkins, Ulster, Warren, Washington, Wyoming and Yates (NYSEMO, 2006; FEMA, 2008; NYSDPC, 2008). Disaster assistance for all counties affected in the State totaled approximately $16.7 million in individual assistance and $103.7 million in public assistance (1997 USD). Onondaga County received $1.1 million in public assistance (1997 USD) (Lumia, 1998).

September 7, 1998 (FEMA DR-1244) ("Syracuse Derecho of Labor Day 1998"): A cluster of fast-moving thunderstorms, known as a derecho, developed over western New York State and moved eastward towards the coast of New England resulting in significant wind and hail damage through much of the area. Figure 5.4.1-14 displays the path of the derecho throughout the northeast U.S.

Figure 5.4.1-14. September 7, 1998 Derecho Storm Path



Source: SPC, Date Unknown
Note: The two derecho events are outlined in green and red. The green indicates the Syracuse Derecho and the red indicates the New York City derecho. Curved purple lines represent the approximate locations of the "gust fronts" at two hourly intervals. "+" symbols indicate the locations of wind damage or wind gusts above severe limits (58 mph or greater). Red dots and paths indicate tornado events. A "gust front" is the leading edge of the downdraft (downward moving air) from a thunderstorm.

Along the storm track, tens of thousands of trees were blown down and over 100 homes and businesses were damaged. Many homes and businesses experienced power outages, some without power for a week (SPC, Date Unknown). Some of the worst damage areas were noted in a band across western and central New York State, within the vicinity of Rochester, Syracuse, and Utica. A total of three people were killed and ten were injured at the New York State Fairgrounds in Syracuse. Wind gusts were measured at 89 mph at the Rochester Airport and 77 mph at the Syracuse airport. Winds were estimated to have reached 115 mph in the areas with the worse damage. Along the storm track of the derecho, tens of thousands of trees were blown down and over 1,000 homes and businesses were damaged. Hundreds of thousands were without power, some without power for a week. Total damages in New York State were estimated at $130 million (1998 USD) (SPC, Date Unknown).

The severe windstorm struck Onondaga County and eight surrounding counties during the early morning of September 7th. Wind speeds in the area ranged between 70 and 90 mph, with gusts of up to 115 mph (Audet, 1998). The storm first entered the County just after 1:00 a.m. on September 7th, tearing through Baldwinsville, bringing down many trees and utility poles. The storm quickly progressed towards Clay across Onondaga Lake to Camillus and Geddes (NCDC, 2008).

The New York State Fairgrounds in Geddes suffered severe damaged. Most of the temporary holding structures and tents on the premises were either completely destroyed or had heavy damage. The winds were so strong that three large flagpoles at the entrance of the fairgrounds were bent to almost a 45 degree angle. Roofs of buildings were torn off, windows were blown out, and siding was damaged because of fallen trees. Two people were killed and seven were injured at the fairgrounds (NCDC, 2008).

In Marcellus and Camillus, thousands of trees were blown down just in this area alone. The Onondaga Hill section's roads were impassable from downed trees and live power lines. Several homes in the area had various degrees of damage to their siding and roofs, mainly from fallen trees. The storm then travelled to Marcellus and on to the Syracuse metropolitan area (NCDC, 2008).

Syracuse felt the brunt of the derecho. Thousands of trees were either damaged or knocked down throughout the city. One of the hardest hit areas was the Thornden Park area near Syracuse University. This section experienced substantial structural damage to nearby homes and buildings. A textile factory's roof was almost completely torn away and many student housing buildings at Syracuse University had windows blown out and damaged roofs. St. Lucy's Church was nearly destroyed when one of its steeples collapsed. Wind gusts at the Hancock International Airport were recorded at 75 mph. One person was killed in Syracuse (NCDC, 2008).

Post-storm damage surveys showed a damage swath 10 to 12 miles long and almost 30 miles wide. Estimated peak wind gusts were near 115 mph. Hundreds of thousands of people were without power. According to NOAA-NCDC and SHELDUS, Onondaga County experienced approximately $90 million in property damage from this event (NCDC, 2008; Hazards and Vulnerability Research Institute, 2007).

In a press release, dated March 26, 2001, from the Onondaga County Office of the County Executive, it was stated that the County was awarded $2.2 million from the New York State Housing Trust Fund Corporation, Disaster Recovery Initiative. The State allocated $12.9 million for 32 counties who were impacted as a result of the 1998 ice storm, tornadoes, flooding, and other severe storms. Onondaga County received the largest allocation for the damage sustained during the September 7th Labor Day Storm. Twenty-five projects were approved and the funding allowed seven municipalities of the County to remove and replace the damaged trees (County of Onondaga, 2001). The following projects were selected:

- Onondaga County: tree removal along Department of Transportation County Roads - $200,000
- Onondaga County: stream clearance and debris removal from streams in Manlius and DeWitt - $65,000
- Syracuse: housing and garage repairs - $645,811
- Syracuse: stream bank stabilization - $400,000
- Syracuse Housing Authority" tree planting - $44,800
- Elbridge: tree work in cemeteries - $5,900
- Fabius: reconstruction of Herlihy Road - $13,350
- Geddes: tree replanting in the Avery Tract - $20,000
- Geddes: stream clearance along Harbor Brook - $25,000
- Manlius: stream clearance along Limestone Creek - $40,000
- Onondaga: unreimbursed cleanup in Nedrow – $9,251
- Onondaga: stream bank stabilization along Onondaga Creek - $120,000
- Camillus: stream bank stabilization along Nine Mile Creek - $116,000
- Camillus: tree removal and replanting - $30,000
- Fayetteville: stream bank stabilization along Limestone Creek - $15,000
- Fayetteville: debris removal along the Ledyard Canal - $10,000
- Jordan: tree removal and replanting - $22,000
- Jordan: stream bank stabilization along Skaneateles Creek - $12,000
- Manlius: stream clearance along Limestone Creek - $37,000
- Marcellus: tree removal and replanting - $11,300
- North Syracuse: tree replanting - $10,000
- Solvay: Boyd Park repairs to play equipment and tennis courts - $1,000
- Solvay: Mountain Top Fire Station façade repairs - $39,500
- Solvay: Cooperative Extension Technical assistance and training - $57,000

- Solvay: Nursery Landscape Association Technical assistance and training - $10,000 (County of Onondaga, 2001)

This storm resulted in a FEMA Disaster Declaration (FEMA DR-1244) on September 11, 1998. Through this declaration, individual and public assistance was given to Cayuga, Fulton, Herkimer, Madison, Monroe, Onondaga, Oneida, Ontario and Wayne (FEMA, 2007; NYSEMO, 2006). Over $36 million was given out in public and individual assistance to those affected counties (NYSDPC, 2008).

May through September 2000 (FEMA DR-1335): Between May and September 2000, multiple severe storm events occurred throughout New York State resulting in significant flooding and over $34.6 million in damage throughout various New York State counties. Flood impacts within New York State and Onondaga County are further mentioned in Section 5.4.3 (Flood).

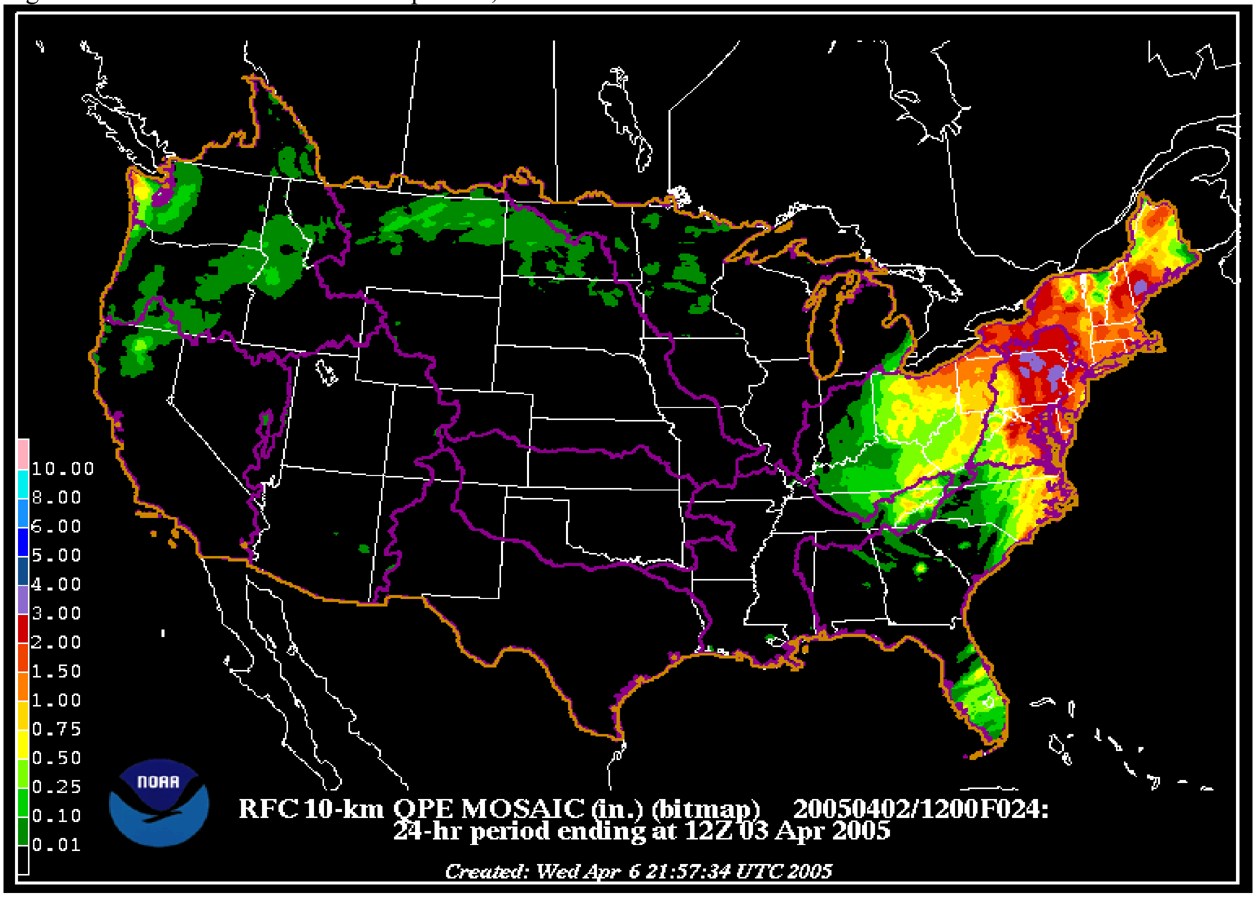
These storms resulted in a FEMA Declaration Disaster (FEMA DR-1335) on July 21, 2000. Through this declaration, the following 27 counties were declared eligible for Federal and State disaster funds: Albany, Allegany, Cattaraugus, Columbia, Dutchess, Erie, Essex, Greene, Herkimer, Lewis, Livingston, Madison, Montgomery, Niagara, Oneida, Onondaga, Orleans, Otsego, Rensselaer, Schenectady, Schoharie, Steuben, Sullivan, Tioga, Tompkins, Ulster and Yates (FEMA, 2003). Disaster assistance for all counties affected in the State was not disclosed in the materials reviewed to develop this plan.

August 13 – September 16, 2004 (FEMA DR-1564): A series of storms occurred between August and September 2004 within New York State, resulting in approximately $18 million in eligible damages (NYSDPC, 2008). NOAA-NCDC indicated that flooding during this time period in Onondaga County particularly occurred as a result of heavy thunderstorms on August 30-31, 2004. Onondaga County experienced approximately $2 million in flood damages from this event (NCDC, 2008). Flood impacts within New York State and Onondaga County are further mentioned in Section 5.4.3 (Flood).

These storms resulted in a FEMA Declaration Disaster (FEMA DR-1564) on October 1, 2004. Through this declaration, the following 17 counties were declared eligible for Federal and State disaster funds: Allegany, Broome, Cattaraugus, Columbia, Delaware, Madison, Monroe, Niagara, Oneida, Onondaga, Orange, Orleans, Steuben, Sullivan, Ulster, Warren, and Wayne Counties (FEMA, 2005). As of December 10, 2004, more than $1.8 million in disaster aid had been approved for the State (FEMA, 2004). Disaster assistance for all counties affected in the State was not disclosed in the materials reviewed to develop this plan.

April 2-4, 2005 (FEMA DR-1589): A slow moving storm moved up through the Appalachians and into the northeast U.S. The heavy rainfall from this event produced flooding throughout New York State, New Jersey and Pennsylvania (NCDC, 2005). Prior to this storm, the rivers and streams in the area had high flow-rates due to a previous rainstorm on March 28th and snowmelt; therefore, flooding increased substantially and created additional damage as a result of this April storm (NYSDPC, 2008). Figure 5.4.1-15 shows rainfall totals from this event for the northeast U.S.

Figure 5.4.1-15. Rainfall Totals for April 2-4, 2005



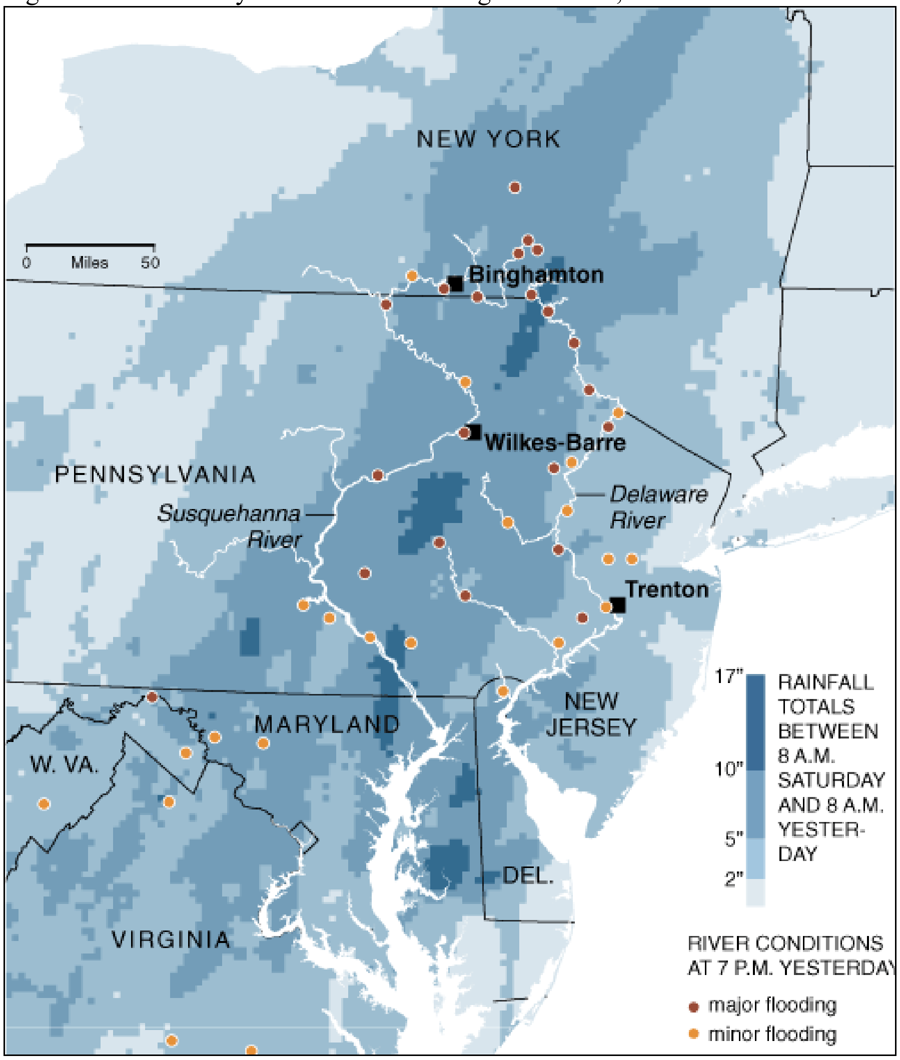
Source: NCDC, 2005

New York State experienced approximately $66.2 million in damages from this event (NYSDPC, 2008), and Onondaga County experienced approximately $100,000 in flood damages (NCDC, 2008; Hazards & Vulnerability Research Institute, 2007). Flood impacts within New York State and Onondaga County are further mentioned in Section 5.4.3 (Flood).

This storm resulted in a FEMA Disaster Declaration (DR-1589) on April 19, 2005. Through this declaration, the following 20 counties were declared eligible for Federal and State disaster funds: Broome, Cayuga, Chautauqua, Chenango, Columbia, Cortland, Delaware, Greene, Madison, Montgomery, Niagara, Orange, Otsego, Putnam, Rensselaer, Schoharie, Sullivan, Tioga, Ulster and Westchester (NYSDPC, 2008; FEMA, 2008). Although Onondaga County suffered flood damages during this storm, it was not declared a disaster area by FEMA.

June 25 – July 12, 2006 (FEMA DR-1650): This severe storm event resulted in a significant flooding that affected much of the Mid-Atlantic region. The flooding was widespread, affecting numerous rivers, lakes and communities from North Carolina to New York State. Rain totals throughout the eastern U.S. ranged from 2 to 17 inches, particularly between June 27th and 29th, with the largest accumulations falling in Maryland, Pennsylvania and New York State (Feuer, 2006) (Figure 5.4.1-16).

Figure 5.4.1-16. 2-Day Rainfall Totals during June 27-28, 2006 Flood

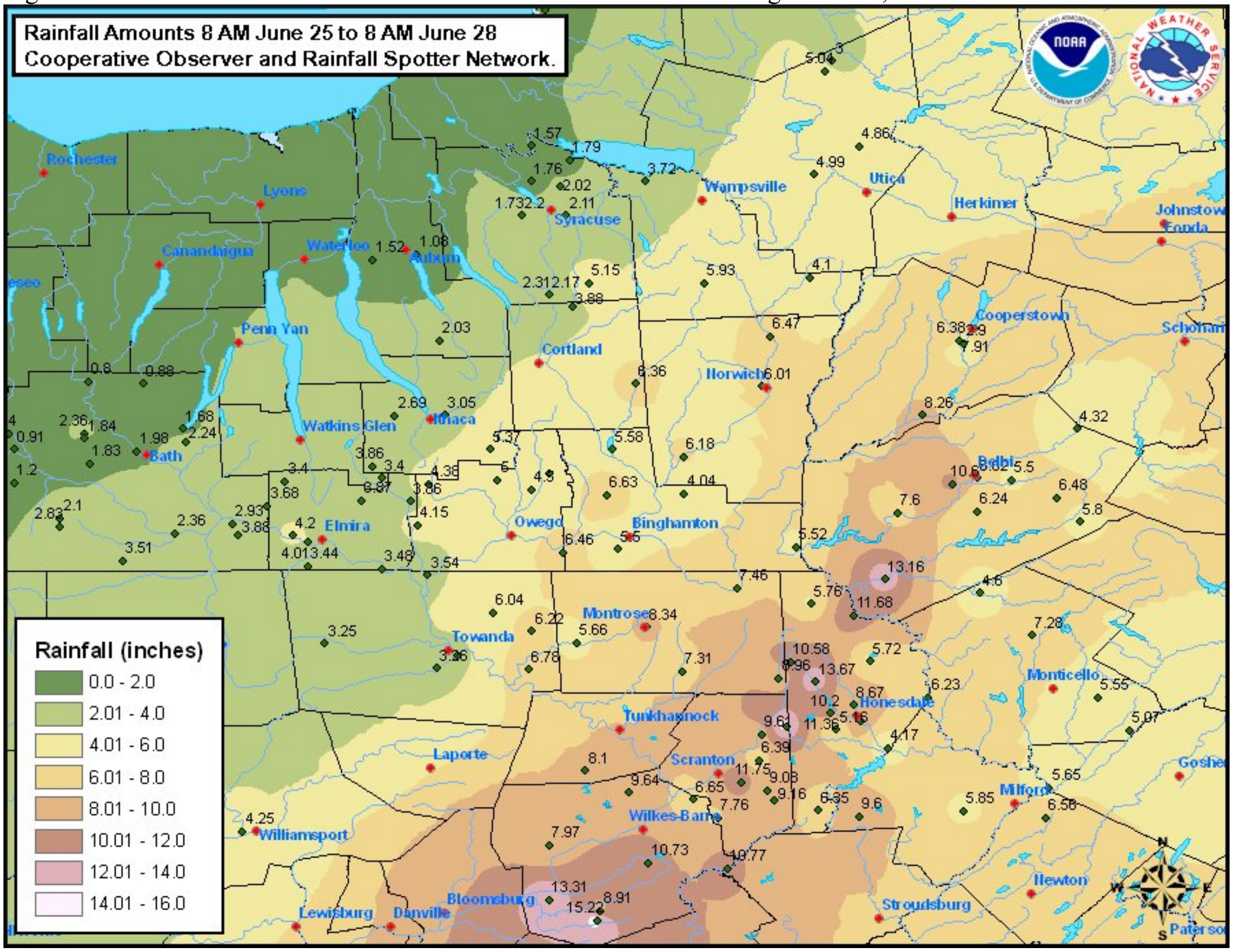


Source: Feuer, 2006
Note: Image provided to source by NWS

Overall, the storm resulted in over 16 deaths and millions of dollars in damages throughout the affected states (NWS, 2006). Some sources indicated that this flooding event was the largest and most costly natural disaster that New York State has encountered since Hurricane Agnes in 1972. The NYS HMP indicated that the counties affected throughout the State experienced approximately $246.3 million in damages during this flood (NYSDPC, 2008).

In Onondaga County, precipitation totals between June 25 through June 28, 2006 averaged between 0 to 6 inches of rain, with largest accumulations generated in the southeastern portion of the County (Figure 5.4.1-17) (NWS, 2006). Over 4.29 inches of rain fell at the Hancock Airport in Syracuse, shattering a 31-year-old rainfall record of 3.9 inches on July 3, 1974 (Goldberg and Greene, 2006). Flood impacts within New York State and Onondaga County are further mentioned in Section 5.4.3 (Flood).

Figure 5.4.1-17 Rainfall Amounts in Central New York on June 25 through June 28, 2006



Source: NWS, 2006

This event resulted in a FEMA Emergency Declaration (FEMA EM-1650) on July 1, 2006. Through this declaration, the following 12 Counties were declared eligible for Federal and State disaster funds: Broome, Chenango, Delaware, Herkimer, Montgomery, Oneida, Orange, Otsego, Schoharie, Sullivan, Tioga, and Ulster Counties (FEMA, 2008). Although Onondaga County was not declared as an official disaster area under this declaration, all counties of the State were eligible to apply for federal assistance under the Hazard Mitigation Grant Program. This program provides assistance to State and local governments and certain private nonprofit organizations for actions taken to prevent or reduce long term risk to life and property from natural hazards. As of December 29, 2006, FEMA indicated that nearly $227 million in disaster aid was made available to all declared counties as result of this event (FEMA, 2008). Disaster assistance for Onondaga County affected in the State was not disclosed in the materials reviewed to develop this plan.

July 29, 2006: A severe storm entered Onondaga County, affecting northern and southern portions of the County. The storm brought heavy rain and strong winds. The winds snapped numerous utility poles, uprooted trees and downed power lines in many areas of the County. This severe storm event produced a microburst over Cicero and a tornado that traveled from Marcellus to Onondaga (Doherty, 2006).

The microburst struck Cicero, with winds of 60 to 80 miles per hour. It snapped utility poles and uprooted trees in Cicero's South Bay and Cicero Center areas. The tornado was a low-grade tornado with winds of 40 to 70 miles per hour. It cut a three-mile swath from Marcellus to Onondaga, downing trees and power lines (Doherty, 2006). Figures 5.4.1-18 and 5.4.1-19 show the damages from the storm that hit the area.

Figure 5.4.1-18. Fallen Trees on Brewerton, New York Home

Source: Greenlar, 2006 (from The Post-Standard)

Figure 5.4.1-19. Downed Trees in Brewerton, New York

Source: Greenlar, 2006 (from The Post-Standard)
Note: Brewerton resident cutting up a tree that fell on the roof of his house during the storm.

The tornado touched down in Marcellus around 4 p.m. The National Weather Service surveyed the affected area and observed that the damage was consistent with a weak tornado. It was estimated that the tornado was an F0 on the Fujita Scale, with winds up to 70 miles per hour. Damage was largely to trees, which were uprooted and snapped. The estimated width of the tornado was approximately 75 yards (NWS, 2006).

The heaviest amount of damage was in the Cicero area, where several roadways were closed due to fallen down trees and power lines (Doherty, 2006). According to NOAA-NCDC and SHELDUS, Onondaga County experienced approximately $17,000 in property damage from this event (NCDC, 2008; Hazards and Vulnerability Research Institute, 2007).

June 10, 2008: Severe thunderstorms occurred in two separate waves on June 10th. The first wave occurred during the morning and produced severe weather across the northern sections of central New York State. The second wave of storms occurred during the afternoon and evening of June 10th, producing scattered reports of damage across central New York State and northeast Pennsylvania (NWS, 2008). A tornado watch was in effect for many counties of New York State, including Onondaga County (NWS, 2008).

In Cicero, maximum wind gusts only reached about 40 mph, which is below severe criteria. Many power outages and some minor damage occurred in southern Cicero. In East Syracuse, large tree limbs were blown down, taking out power lines in many locations and causing other generally minor damage. The strong winds also ripped part of the roof off of Bishop Ludden Jr./Sr. High School in Syracuse (Smith, 2008). Figures 5.4.1-20 and 5.4.1-21 present tree and power line damage in East Syracuse:

Figure 5.4.1-20. Maconi Street in East Syracuse

Figure 5.4.1-21. East Avenue in East Syracuse

Source: Smith, 2008
Note: Photographs taken by Kevin Smith

Probability of Future Events

In Section 5.3, the identified hazards of concern for Onondaga County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the County Planning Committee, the probability of occurrence for severe storms in Onondaga County is considered frequent (likely to occur more than once every 5 years, as presented in Table 5.3-3); however, impacts only related to severe storms, excluding those associated with hurricanes, tropical storms, Nor'easters and flooding, are expected to be minimal.

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

The Role of Global Climate Change on Future Probability

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts, storms and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Human-induced climate change has the potential to alter the prevalence and severity of extremes such as heat waves, cold waves, severe storms, floods and droughts. Though predicting changes in these types of events under a changing climate is difficult, understanding vulnerabilities to such changes is a critical part of estimating future climate change impacts on human health, society and the environment.

It is important to understand that directly linking any one specific extreme event (for example, a severe hurricane) to climate change is not possible. However, climate change and global warming may increase the probability of some ordinary weather events reaching extreme levels or of some extreme events becoming more extreme (U.S. Environmental Protection Agency [USEPA], 2006). It remains very difficult to assess the impact of global warming on extreme weather events, in large part because this analysis depends greatly on regional forecasts for global warming. Global warming will almost certainly have different effects on different regions of the Earth, so areas will not be equally susceptible to increased or more intense extreme weather events. Although regional climate forecasts are improving, they are still uncertain (Climate Institute, Date Unknown). These many uncertainties may exist regarding magnitude or severity; however, many sources indicate that future weather patterns and increased intensities are anticipated as a result of climate change, along with atmospheric, precipitation, storm and sea level changes (USEPA, 2007).

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For severe storms, the entire County has been identified as the hazard area. Therefore, all assets in Onondaga County (population, structures, critical facilities and lifelines), as described in the County Profile section, are vulnerable. The following text evaluates and estimates the potential impact of severe storms including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact, including: (1) impact on life, safety and health of County residents, (2) general building stock, (3) critical facilities, (4) economy and (5) future growth and development
- Further data collections that will assist understanding of this hazard over time
- Overall vulnerability conclusion

Overview of Vulnerability

Severe storms include high wind speeds that result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and the need to shelter and care for individuals impacted by the events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and, in some cases, people. The risk assessment for severe storm evaluates available data for a range of storms included in this hazard category.

Due to the County's inland location, the loss associated with hurricanes is primarily associated with severe winds characteristic of tropical cyclones/storms and severe thunderstorm or hurricane-related rains (see flooding discussion in Section 5.4.3 Flood). Secondary flooding associated with the torrential downpours during hurricanes/tropical storms is also a primary concern in the County. The County has experienced flooding in association with several hurricanes and tropical storms in the past.

In the study area, winds associated with a hurricane event are similar to a severe wind storm and therefore, can support analysis of the severe storm event for this study area. The entire inventory of the County is at risk of being damaged or lost due to impacts of severe wind. Certain areas, infrastructure, and types of building are at greater risk than others due to proximity to falling hazards and/or their manner of construction.

Potential losses associated with high wind events were calculated for the County for two probabilistic hurricane events, the 100-year and 500-year MRP hurricane events. The impacts on population, existing structures and critical facilities are presented below, following a summary of the data and methodology used.

Data and Methodology

After reviewing historic data, the HAZUS-MH methodology and model were used to analyze the hurricane hazard for Onondaga County. Data used to assess this hazard include data available in the HAZUS-MH hurricane model, NOAA NCDC data, professional knowledge, information provided by the Planning Committee, and public input.

HAZUS-MH contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Hurricane and inventory data available in HAZUS-MH were used to evaluate potential losses from the 100- and 500-year MRP hurricane event (severe wind impacts). Locally available inventory data were reviewed to determine their appropriateness for inclusion. Other than data for critical facilities, the default data in HAZUS-MH was the best available for use in this evaluation. The 11 residential and 10 commercial occupancy classes available in HAZUS-MH were condensed into the following occupancy classes (residential, commercial, industrial, agricultural, religious, government, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address both multi-family and single family dwellings. In addition, impacts to critical facilities were evaluated for the 100-year and 500-year MRP events.

Impact on Life, Health and Safety

The impact of severe storms on life, health and safety is dependent upon the severity of the storm event. Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. It is assumed that the entire County population is exposed to the severe storm hazard. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 5.4.1-7 summarizes the population over the age of 65 and individuals living below the Census poverty threshold. Additionally, residents living in mobile homes are particularly vulnerable to wind events due to the construction of their housing. The Impact on General Building Stock subsection below discusses mobile homes in the County further.

Table 5.4.1-7. Vulnerable Population Exposed to the Severe Storm Hazard in Onondaga County

Population Category	Number of Persons Exposed	Percent of Total County Population
Elderly (Over 65 years of age)	63,342	13.8
Persons living below Census poverty threshold*	54,208	11.8
Elderly (Over 65 years of age) living below Census poverty threshold	4,299	0.9

Source: U.S. Census 2000.
* The Census poverty threshold for a three person family unit is approximately $15,000.

HAZUS-MH estimates that zero households will be displaced and zero households will require temporary shelter as a result of the 100- and 500-year MRP events. Additionally, HAZUS-MH does not anticipate any brick, wood or tree debris will be generated as a result of these events. However, please note that the HAZUS-MH Hurricane Model Technical Manual and User Manual recommend that the estimated debris volume be treated as a low estimate. There may be other sources of vegetative and non-vegetative debris (i.e., flooding) not being modeled in HAZUS-MH in combination with the wind. Therefore, this is likely a conservative estimate and may be higher if multiple impacts occur.

Impact on General Building Stock

After considering the population exposed to the severe storm hazard, the value of general building stock exposed to and damaged by 100- and 500-year MRP events was evaluated. Potential damage is the modeled loss that could occur to the exposed inventory. HAZUS-MH estimates there is a total building replacement value (structure only) of greater than $40 billion in the County. Nearly 70-percent of the building stock structural value is associated with residential housing. The analysis below uses the default general building stock data as reported in HAZUS-MH MR3, generated using 2000 U.S. Census data.

Table 5.4.1-8 presents the total exposure value for general building stock by occupancy class for the County.

Table 5.4.1-8. Building Stock Replacement Value (Structure Only) by Occupancy Class

Jurisdiction	Total RV	Residential RV	Commercial RV	Industrial RV
Village of Baldwinsville	$547,901,000	$420,743,000	$85,786,000	$6,945,000
Town of Camillus	$1,699,197,000	$1,390,860,000	$231,737,000	$18,180,000
Village of Camillus	$105,960,000	$76,765,000	$9,496,000	$16,929,000
Town of Cicero	$2,128,239,000	$1,602,798,000	$332,118,000	$96,778,000
Town of Clay	$4,002,126,000	$3,181,545,000	$579,820,000	$125,465,000
Town of Dewitt	$3,112,791,000	$1,508,217,000	$1,064,659,000	$387,956,000
Village of East Syracuse	$256,948,000	$149,872,000	$74,587,000	$17,017,000
Town of Elbridge	$234,598,000	$177,892,000	$20,333,000	$25,338,000
Village of Elbridge	$76,616,000	$52,547,000	$14,534,000	$2,779,000
Town of Fabius	$117,842,000	$101,330,000	$7,849,000	$2,347,000
Village of Fabius	$26,471,000	$21,503,000	$1,065,000	$1,683,000
Village of Fayetteville	$365,480,000	$278,301,000	$63,527,000	$3,809,000
Town of Geddes	$939,435,000	$722,317,000	$150,564,000	$40,342,000
Village of Jordan	$102,876,000	$66,615,000	$13,294,000	$7,182,000
Town of Lafayette	$332,816,000	$263,112,000	$38,503,000	$11,541,000
Village of Liverpool	$223,159,000	$150,412,000	$49,989,000	$2,476,000
Town of Lysander	$1,264,582,000	$1,000,149,000	$145,908,000	$35,197,000
Town of Manlius	$1,640,235,000	$1,388,856,000	$158,926,000	$28,239,000
Village of Manlius	$466,020,000	$319,816,000	$119,307,000	$9,724,000
Town of Marcellus	$337,290,000	$287,928,000	$26,627,000	$10,046,000
Village of Marcellus	$154,560,000	$118,067,000	$18,054,000	$5,202,000
Village of Minoa	$224,308,000	$190,989,000	$23,277,000	$1,653,000
Village of North Syracuse	$533,273,000	$415,269,000	$77,651,000	$15,210,000
Town of Onondaga	$1,723,624,000	$1,376,435,000	$234,815,000	$33,756,000
Town of Otisco	$177,335,000	$148,398,000	$18,923,000	$4,224,000
Town of Pompey	$474,122,000	$411,950,000	$35,577,000	$12,738,000
Town of Salina	$2,724,945,000	$1,837,629,000	$636,912,000	$160,533,000
Town of Skaneateles	$501,951,000	$357,951,000	$65,346,000	$66,964,000
Village of Skaneateles	$282,810,000	$174,970,000	$48,838,000	$3,748,000
Village of Solvay	$530,608,000	$375,694,000	$85,534,000	$39,817,000

Jurisdiction	Total RV	Residential RV	Commercial RV	Industrial RV
Town of Spafford	$174,667,000	$162,136,000	$7,039,000	$1,321,000
City of Syracuse	$13,618,388,000	$8,355,655,000	$2,995,398,000	$394,839,000
Town of Tully	$155,920,000	$123,715,000	$16,804,000	$12,230,000
Village of Tully	$90,966,000	$59,337,000	$20,814,000	$792,000
Town of Van Buren	$794,959,000	$620,836,000	$105,519,000	$47,747,000
Onondaga County	**$40,143,018,000**	**$27,890,609,000**	**$7,579,130,000**	**$1,650,747,000**

Source: HAZUS-MH MR3, 2007

Notes:

(1) Replacement value (RV) reflects the building structure and does not include building contents. The valuation of general building stock and the loss estimates determined in Onondaga County were based on the default general building stock database provided in HAZUS-MH MR3. The general building stock valuations provided in HAZUS-MH MR3 are Replacement Cost Value from RSMeans as of 2006.

(2) Total RV is the sum of all building classes (Residential, Commercial, Industrial, Agricultural, Religious, Government and Education).

Table 5.4.1-8. Building Stock Replacement Value (Structure Only) by Occupancy Class (Continued)

Jurisdiction	Agriculture RV	Religious RV	Government RV	Education RV
Village of Baldwinsville	$1,418,000	$14,001,000	$6,873,000	$12,135,000
Town of Camillus	$4,861,000	$23,354,000	$8,662,000	$21,543,000
Village of Camillus	$637,000	$1,035,000	$416,000	$682,000
Town of Cicero	$9,180,000	$29,957,000	$11,863,000	$45,545,000
Town of Clay	$8,478,000	$57,730,000	$29,152,000	$19,936,000
Town of Dewitt	$8,278,000	$85,069,000	$8,568,000	$50,044,000
Village of East Syracuse	$1,247,000	$2,947,000	$7,487,000	$3,791,000
Town of Elbridge	$4,581,000	$2,758,000	$374,000	$3,322,000
Village of Elbridge	$549,000	$1,536,000	$2,590,000	$2,081,000
Town of Fabius	$3,132,000	$363,000	$651,000	$2,170,000
Village of Fabius	$0	$822,000	$0	$1,398,000
Village of Fayetteville	$1,336,000	$6,291,000	$10,583,000	$1,633,000
Town of Geddes	$697,000	$11,311,000	$6,307,000	$7,897,000
Village of Jordan	$410,000	$11,034,000	$3,179,000	$1,162,000
Town of Lafayette	$3,487,000	$7,141,000	$2,601,000	$6,431,000
Village of Liverpool	$1,022,000	$8,066,000	$2,851,000	$8,343,000
Town of Lysander	$68,735,000	$7,463,000	$3,651,000	$3,479,000
Town of Manlius	$8,046,000	$17,661,000	$2,366,000	$36,141,000
Village of Manlius	$987,000	$7,661,000	$4,487,000	$4,038,000
Town of Marcellus	$4,943,000	$607,000	$6,475,000	$664,000
Village of Marcellus	$464,000	$6,497,000	$3,796,000	$2,480,000
Village of Minoa	$1,547,000	$3,220,000	$1,385,000	$2,237,000
Village of North Syracuse	$826,000	$12,033,000	$2,813,000	$9,471,000
Town of Onondaga	$10,654,000	$23,827,000	$12,868,000	$31,269,000
Town of Otisco	$1,757,000	$1,775,000	$604,000	$1,654,000
Town of Pompey	$5,340,000	$4,495,000	$3,847,000	$175,000
Town of Salina	$6,325,000	$32,281,000	$26,919,000	$24,346,000
Town of Skaneateles	$5,449,000	$3,413,000	$2,719,000	$109,000
Village of Skaneateles	$782,000	$9,152,000	$4,773,000	$40,547,000
Village of Solvay	$462,000	$6,011,000	$13,265,000	$9,825,000

Jurisdiction	Agriculture RV	Religious RV	Government RV	Education RV
Town of Spafford	$1,526,000	$363,000	$2,282,000	$0
City of Syracuse	$14,190,000	$320,759,000	$161,102,000	$1,376,445,000
Town of Tully	$1,392,000	$1,681,000	$0	$98,000
Village of Tully	$228,000	$1,370,000	$2,463,000	$5,962,000
Town of Van Buren	$4,805,000	$9,716,000	$3,061,000	$3,275,000
Onondaga County	**$187,771,000**	**$733,400,000**	**$361,033,000**	**$1,740,328,000**

Source: HAZUS-MH MR3, 2007

Notes:

(1) Replacement value (RV) reflects the building structure and does not include building contents. The valuation of general building stock and the loss estimates determined in Onondaga County were based on the default general building stock database provided in HAZUS-MH MR3. The general building stock valuations provided in HAZUS-MH MR3 are Replacement Cost Value from RSMeans as of 2006.

(2) Total RV is the sum of all building classes (Residential, Commercial, Industrial, Agricultural, Religious, Government and Education).

The HAZUS-MH MR3 hurricane analysis considers damage associated with significant winds. Such wind impacts also could occur as a result of the severe wind storms or tornadoes and therefore, are considered relevant to the severe storm hazard. Rain often is associated with hurricanes and heavy rains could result in flooding. Flooding is addressed under the flood hazard in Section 5.4.3.

The entire study area is considered at risk for the severe storm wind hazard. Expected building damage was evaluated by HAZUS-MH across the following damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 5.4.1-9 summarizes the definition of the damage categories.

Table 5.4.1-9. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
1. No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof over, with no or very Limited water penetration.	≤2%	No	No	No	No	No
2. Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be Covered to prevent additional water Entering the building. Marks or dents on walls requiring painting or patching for repair.	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No
3. Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	>15% and ≤50%	> one and ≤ the larger of 20% and 3	1 to 3 panel s	Typically 5 to 10 impacts	No	No
4. Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% and 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
5. Destruction Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

Source: HAZUS-MH Hurricane Technical Manual

As noted earlier in this profile, wind speeds associated with the 100-year MRP event are less than 50 mph, characteristic of a tropical cyclone or tropical storm. Similarly, wind speeds for the 500-year MRP range from 39 to 56 mph; wind speeds characteristic of tropical storm. Wind speeds are highest in the southeastern portion of the County, closest to the storm track. Because the estimated wind risk is low, there are only minor structural damages estimated.

In summary, HAZUS-MH MR3 does not estimate any structural damage as a result of the 100-year MRP event. HAZUS-MH MR3 only estimates minor building damage to the residential occupancy class as a result of the 500-year event. Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Mobile homes are particularly vulnerable to severe storms and wind damage. According to HAZUS-MH MR3, there are a total of 3,565 mobile homes in the County with a structural replacement value of approximately $3,000 each. Of the structural damage estimated as a result of the 500-year event, nearly half is to manufactured homes (mobile homes) in Onondaga County.

Table 5.4.1-10 summarizes the general building stock damage estimated for the 100- and 500-year MRP wind events for Onondaga County. Table 5.4.1-11 summarizes the general building stock damage estimated for the 100- and 500-year MRP events for each participating jurisdiction. The data shown in both tables indicate total losses associated with wind damage to building structure only.

Table 5.4.1-10. Estimated Onondaga County Building Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Hurricane-Related Winds

Occupancy Category	Building Value Damage (Structure Only)	
	100-Year MRP Event	500-Year MRP Event
Total (All Occupancies)	$0	< $500
Residential	$0	< $500
Commercial	$0	$0
Industrial	$0	$0
Agricultural, Religious Government , Education	$0	$0

Source: HAZUS-MH MR3, 2007
Note: MRP = Mean return period

Table 5.4.1-11. Estimated Building Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Hurricane-Related Winds

Municipality	Total Buildings		Percentage of Total Building Value		Residential Buildings		Commercial Buildings		Industrial Buildings	
	100 Yr	500 Yr	100 Yr	500 Yr	100 Yr	500 Yr	100 Yr	500 Yr	100 Yr	500 Yr
Camillus (T)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Camillus (V)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Cicero (T)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Clay (T)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
DeWitt (T)	$0	< $200	0%	< 1%	$0	< $200	$0	$0	$0	$0
East Syracuse (V)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Elbridge (T) and Elbridge (V) and Jordan (V)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Fabius (T) and Fabius (V)	$0	< $200	0%	< 1%	$0	< $200	$0	$0	$0	$0
Geddes (T)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Lafayette (T)	$0	< $50	0%	< 1%	$0	< $50	$0	$0	$0	$0
Lysander (T) and northern portion of Baldwinsville (V)	$0	$0	0%	0%	$0	< $50	$0	$0	$0	$0
Manlius (T), Manlius (V), Minoa (V), Fayetteville (V)	$0	< $50	0%	< 1%	$0	$0	$0	$0	$0	$0
Marcellus (T) and Marcellus (V)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
North Syracuse (V)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Onondaga (T)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Otisco (T)	$0	$0	0%	0%	$0	< $50	$0	$0	$0	$0
Pompey (T)	$0	< $50	0%	< 1%	$0	$0	$0	$0	$0	$0
Salina (T)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Skaneateles (T) and Skaneateles (V)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Solvay (V)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Spafford (T)	$0	$0	0%	0%	$0	$0	$0	$0	$0	$0
Syracuse (C)	$0	$0	0%	0%	$0	< $50	$0	$0	$0	$0
Tully (T) and Tully (V)	$0	< $50	0%	< 1%	$0		$0	$0	$0	$0
Van Buren (T) and southern portion of Baldwinsville (V)	$0	$0	0%	0%	$0	< $500	$0	$0	$0	$0
Onondaga County	**$0**	**< $500**	**0%**	**< 1%**	**$0**	**< $500**	**$0**	**$0**	**$0**	**$0**

Source: HAZUS-MH MR3, 2007

Note: These estimates were calculated on a Census-Tract level. MRP = Mean return period. Yr = Year.

Although the estimated maximum wind gust speeds for the 100- and 500-year events are relatively low (tropical cyclone/tropical storm speeds) and HAZUS-MH MR3 estimates very little structural damage as a result of these winds, Onondaga has experienced more severe storms with higher wind speeds as evidenced by historic storm events. For example, wind gusts at the Hancock International Airport were recorded at 75 mph in September 1998 (DR-1244). These wind speeds equate to a Category 1 hurricane. This September 1998 storm event downed thousands of trees in the City of Syracuse alone, caused power outages and damaged homes and businesses across Onondaga County (SPC, Date Unknown; NCDC, 2008). According to NOAA-NCDC and SHELDUS, Onondaga County experienced approximately $90 million in property damage from this event (NCDC, 2008; Hazards and Vulnerability Research Institute, 2007). Additional losses are described earlier in this profile.

Impact on Critical Facilities

HAZUS-MH MR3 does not estimate any damage to the police departments, fire stations, medical facilities and schools in Onondaga County as a result of the 100- and 500-year events. All facilities, including municipal halls, shelters and senior facilities identified by Onondaga County as critical structures, are estimated to be fully functional (no loss of use) after these events.

Impact on Economy

Severe storms also have impacts on the economy, including: loss of business function, damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings. HAZUS-MH estimates the total economic loss associated with each storm scenario (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 damage sustained during the earthquake.

HAZUS-MH does not estimate any business interruption losses will occur as a result of the 100- and 500-year MRP events. In general, transportation lifelines are not considered particularly vulnerable to the 100- and 500-year MRP severe storm wind hazard. However, utility structures could suffer damage associated with falling tree limbs or other debris as evidenced by the September 1998 storm event (DR-1244). Such impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to citizens (including the young and elderly, who are particularly vulnerable to temperature-related health impacts).

It is estimated that the impact to the economy, as a result of severe storm event, would be considered "frequent" in accordance with the risk ranking shown in Table 5.3-3.

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the severe storm hazard because the entire planning area is exposed and vulnerable.

Additional Data and Next Steps

Over time, Onondaga County will obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts, additional information on estimated frequency of these events, and future data regarding events and damages as they occur. In addition, information on particular buildings or infrastructure and their value will support updates regarding the particular assets in the County that are most vulnerable to severe storm (wind-related) events. Additional utility data would support an improved assessment of potential damage for this infrastructure category.

For the severe storm events that cannot currently be modeled in HAZUS-MH (tornado, thunderstorm, etc.), additional detailed loss data from past and future events will assist in assessing potential future losses. Based on these values and a sufficient number of data points, future losses could be modeled. Alternately, -percent of damage estimates could be made and multiplied by the inventory value to estimate potential losses. This methodology is based on FEMA's How To Series (FEMA 386-2), Understanding Your Risks, Identifying and Estimating Losses (FEMA, 2001) and FEMA's Using HAZUS-MH for Risk Assessment (FEMA 433) (FEMA, 2004). Finally, with time, HAZUS-MH will be released with modules that address hurricane wind and associated flooding as one model and will include a tornado module. As this version of HAZUS-MH is released, the County can run analyses for the tornado hazard and re-run an analysis for an overall picture of the hurricane-associated wind and flood damages.

Overall Vulnerability Assessment

Severe storms are common in the study area, often causing impacts and losses to the structures, facilities, utilities, and population in Onondaga County. Existing and future mitigation efforts should continue to be developed and employed that will enable the study area to be prepared for these events when they occur. The overall hazard ranking determined by the Planning Committee for this hazard is "high" (see Table 5.3-6).