5.4.9 Severe Storm

This section provides a hazard profile and vulnerability assessment of severe storm hazards for the Allegany County Hazard Mitigation Plan (HMP).

5.4.9.1 Hazard Profile

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

Description

For the purpose of this HMP and as deemed appropriated by Allegany County, the severe storm hazard includes hailstorms; windstorms; tornadoes; and thunderstorms, lightning, and hurricanes; which are defined in the sections below. Northeasters (or Nor'easters) are a type of extra-tropical cyclone that most frequently occur during winter months; however, Allegany County's location in western New York means that the County is not susceptible to Nor'easters; therefore, they are not profiled in this HMP.

Hailstorms

Hail forms inside a thunderstorm with strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32 degrees Fahrenheit (°F) or colder. As the frozen droplet begins to fall, it may thaw as it moves into warmer air toward the bottom of the thunderstorm. However, the droplet may be picked up again by another updraft and carried back into the cold air and re-freeze. With each trip above and below the freezing level, the frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail. Most hail is small and typically less than two (2) inches in diameter (National Weather Service [NWS] 2010).

Windstorms

High winds, other than tornadoes, are experienced in all parts of the United States. Areas that experience the highest wind speeds are coastal regions from Texas to Maine, and the Alaskan coast; however, exposed mountain areas experience winds at least as high as those along the coast (Federal Emergency Management Agency [FEMA] 1997). Wind begins with differences in air pressures and occurs through rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds have the potential to down trees, tree limbs, and power lines, which may lead to widespread power outages, and damage residential and commercial structures throughout Allegany County. High winds are often associated with other severe weather events such as thunderstorms, tornadoes, hurricanes, and tropical storms (all discussed further in this section). The following table provides the wind descriptions used by NWS.

Table 5.4.9-1. NWS Wind Descriptions

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

Source: NWS 2010
Notes:
mph Miles per hour
NWS National Weather Service

Tornadoes

Tornadoes are nature's most violent storms and can cause fatalities and devastate neighborhoods in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 miles per hour (mph). Damage paths can be greater than one (1) mile in width and 50 miles in length. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds between 30 and 125 mph and can generate internal wind speeds exceeding 300 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997).

Thunderstorms

A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS 2009d). A thunderstorm forms from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as a warm or cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. Although thunderstorms generally affect a small area when they occur, they have the potential to become dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and lightning. NWS considers a thunderstorm severe if it produces damaging wind gusts of 58 mph or higher, hail one (1) inch (quarter size) in diameter or larger, or tornadoes (NWS 2010).

Lightning is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and may be very dangerous. Lightning can damage homes and injure people. In the United States, an average of 300 people are injured, and 80 people are killed by lightning each year. Lightning can occur anywhere there is a thunderstorm.

Thunderstorms can lead to flooding, landslides, strong winds, and lightning. Roads may become impassable from flooding, downed trees or power lines, or a landslide. Downed power lines can lead to loss of utility services, such as water, phone, and electricity. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the United States, with approximately 10 percent of them classified as severe. During the warm season, thunderstorms are responsible for most of the rainfall.

Hurricanes and Tropical Storms

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

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain (winds are at a lower speed than hurricane-force winds, thus gaining its status as tropical storm versus a hurricane). Tropical storms strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. They are fueled by a different heat mechanism than other cyclonic windstorms such as Nor'easters and polar lows. The characteristic that separates tropical storms from other cyclonic systems is that at any height in the atmosphere, the center of a tropical storm will be warmer than its surroundings, a phenomenon called "warm core" storm systems (National Oceanic and Atmospheric Administration [NOAA] 1999).

The NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical storm becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- *Hurricane/Typhoon Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical storm. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm force winds (24 hours in the western north Pacific). The warning can remain in effect when dangerously high water or a combination of dangerously high water and waves continue, even though winds may be less than hurricane force.
- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours (24 hours for the western north Pacific) in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm (NWS 2013).

One of the most severe impacts associated with hurricanes is storm surge; however, due to Allegany County's location, storm surge is not a concern for the County and has not been detailed in this profile.

Extent

The extent or severity of a severe storm is largely dependent upon sustained wind speed. In extreme cases, straight-line winds, which are winds that come out of a thunderstorm, 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.

This section describes the extent of hail, lighting, windstorms and high wind, thunderstorms, tornados, and hurricanes and tropical storms in Allegany County, in addition to providing a discussion of the mean return period for the severe storm hazard.

Hail

The severity of a hail storm is measured by duration, hail size, and geographic extent. All of these factors are directly related to thunderstorms, which create hail. The severity components of hail vary widely, with the most significant impact being damage to crops. Hail also has the potential to damage structures and vehicles during hailstorms.

Hail can be produced from many different types of storms; however, hail typically occurs with thunderstorm events, and the size of hail is estimated by comparing it to a known object. Most hail storms are made up of a variety of sizes, and only the very largest hail stones pose serious risk to people, if exposed (New York State Division of Homeland Security and Emergency Services [NYS DHSES] 2014). Table 5.4.9-2 describes the different types of hail as compared to real-world objects, and lists approximate measurements.

Table 5.4.9-2. Hail Size

Description	Diameter (in inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.88
Quarter	1.00
Half dollar	1.25
Walnut or ping pong ball	1.50
Golf ball	1.75
Hen’s egg	2.00
Tennis ball	2.75
Baseball	2.75
Tea cup	3.00
Grapefruit	4.00
Softball	4.50

Source: NYS DHSES 2014

Lightning

As with hail, lightning can be produced by a wide variety of situations, but is most often associated with moderate to severe thunderstorms. As noted previously, lightning is responsible for deaths, injuries, and property damage in all areas of the United States. Lightning-based deaths and injuries typically involve heart damage, inflated lungs, or brain damage, as well as loss of consciousness, amnesia, paralysis, and burns, depending on the severity of the strike. Lightning can also spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems.

Despite the potential damage associated with lightning, most strikes do not hit anything important (such as persons, animals, or local assets). Additionally, the majority of people struck by lightning survive, although they may have severe burns and internal damage (as mentioned above). Multiple devices are available to track and monitor the frequency of lightning strikes; however, most jurisdictions only focus on cloud-to-ground lightning that occurs during periods of dry heat or when associated with severe storms.

Windstorms and High Winds

Table 5.4.9-3 provides the NWS descriptions of winds during wind-producing events.

Table 5.4.9-3. NWS Wind Descriptions

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

Source: NWS 2015

NWS issues advisories and warnings for winds, which are normally site-specific. High wind advisories, watches, and warnings are issued by the NWS when wind speeds may pose a hazard or may be life threatening. The criterion for each of these varies from state to state. Wind warnings and advisories for New York State are as follows:

- *High Wind Warnings* are issued when sustained winds of 40 mph or greater are forecast for one (1) hour or longer, or wind gusts of 58 mph or greater are forecast for any duration.
- *Wind Advisories* are issued when sustained winds of 30 to 39 mph are forecast for one (1) hour or longer, or wind gusts of 46 to 57 mph are forecast for any duration (NWS 2015).

Thunderstorms

Severe thunderstorm watches and warnings are issued by the local NWS office and NOAA's Storm Prediction Center (SPC). NWS and SPC will update the watches and warnings and will notify the public when they are no longer in effect. Watches and warnings for thunderstorms in New York are as follows:

- *Severe Thunderstorm Warnings* are issued when there is evidence based on radar or a reliable spotter report that a thunderstorm is producing (or is forecast to produce) wind gusts of 58 mph or greater, structural wind damage, and hail one (1) inch in diameter or greater. A warning will include the location of the storm, the municipalities that are expected to be impacted, and the primary threat associated with the severe thunderstorm warning. After it has been issued, the NWS office will follow up periodically with Severe Weather Statements, which contain updated information on the severe thunderstorm and will let the public know when the warning is no longer in effect (NWS 2009, 2010).
- *Severe Thunderstorm Watches* are issued by the SPC when conditions are favorable for the development of severe thunderstorms over a larger-scale region for a duration of at least three (3) hours. Tornadoes are not expected in such situations, but isolated tornado development may also occur. Watches are normally issued well in advance of the actual occurrence of severe weather. During the watch, NWS will keep the public informed on developments happening in the watch area and will also notify the public when the watch has expired or been cancelled (NWS 2009, 2010).

- *Special Weather State for Near Severe Thunderstorms* bulletins are issued for strong thunderstorms that are below severe levels, but still may have some adverse impacts. Usually, they are issued for the threat of wind gusts of 40 to 58 mph or small hail less than one (1) inch in diameter (NWS 2010).

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). The F-Scale 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 (The Tornado Project n.d.). The F-Scale categorizes each tornado by intensity and area and is divided into six categories, F0 (Gale) to F5 (Incredible) (Edwards 2012). Table 5.4.9-4 explains each of the six F-Scale categories.

Table 5.4.9-4. 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. Surfaces peel off roofs; mobile homes pushed off foundations or overturned; moving automobiles 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 the 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 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 become airborne for over 100 meters (109 yards); trees debarked; incredible phenomena occur.

Source: SPC 2012
Notes:
mph Miles per hour

The Enhanced Fujita Scale (EF-Scale) is now the standard used to measure the strength of a tornado. The EF-Scale 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 (DI) and Degrees of Damage (DOD), which help better estimate the range of wind speeds produced by the tornado. A rating is assigned based on the list of DIs and DODs; the rating 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 tornado damage surveys. This new scale considers the design of most structures (NOAA 2008). Table 5.4.9-5 displays the EF-Scale and each of its six categories.

Table 5.4.9-5. 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.
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 some distance.
EF4	Devastating Tornado	166-200	Devastating damage. Well-constructed houses and whole frame houses completely leveled; cars thrown; small missiles generated.
EF5	Incredible Tornado	>200	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles become airborne for over 100 meters (109 yards); Significant structural deformation occurs to high-rise buildings; incredible phenomena occur.

Source: SPC n.d.

Tornado watches and warnings are issued by the local NWS office. A tornado watch is issued when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2013; FEMA 2013).

Hurricanes and Tropical Storms

The term used to identify a tropical cyclone based on the strength of its winds. Hurricanes are further categorized. The extent of a hurricane is categorized by the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventive measures (NHC 2015). Table 5.4.9-6 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes land fall.

Table 5.4.9-6. The Saffir-Simpson Hurricane Scale

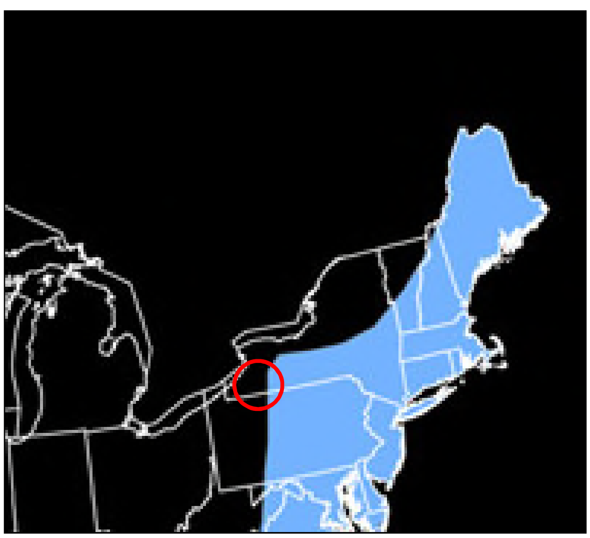
Category	Wind Speed	Storm Surge	Expected Damage
1	74-95 mph	Three (3) to Five (5) feet	Very dangerous winds will produce some damage. Homes with well-constructed frames could have damage to roof, shingles, vinyl siding, and gutters. Large tree branches will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	Six (6) to Eight (8) feet	Extremely dangerous winds will cause extensive damage. Homes with well-constructed frames could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block roads. Near-total power loss is expected with outages that could last from several days to weeks.

Category	Wind Speed	Storm Surge	Expected Damage
3 (major)	111-129 mph	Nine (9) to 12 feet	Devastating damage will occur. Homes with well-built frames may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph	13 to 18 feet	Catastrophic damage will occur. Homes with well-built frames can sustain severe damage with loss of most of the roof structure and some exterior walls. Most trees will be snapped or uprooted and power poles will be downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	>157 mph	19+ feet	Catastrophic damage will occur. A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: NHC 2013; National Aeronautics and Space Administration (NASA) 2003
Notes:
mph = Miles per hour
> = Greater than

Figure 5.4.9-1 illustrates the number of hurricanes expected to occur during a 100-year period. According to this map, portions of New York State (although not including Allegany County) can expect between 20 and 40 hurricanes during a 100-year return period. While Allegany County does not have as high a frequency of hurricanes as other New York counties, it is still important for the county be prepared because responders may need to support other counties impacted by severe hurricanes.

Figure 5.4.9-1. Number of Hurricanes for a 100-year Mean Return Period



Source: U.S. Geological Survey (USGS) 2005
Notes:
Red circle indicates Allegany County's approximate location within the region.
The map shows the number of hurricanes expected to occur during a 100-year mean return period based on historical data using the following scale:
Light blue area 20 to 40

Mean Return Period

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). For example, a flood that has a 1-percent chance of being equaled or exceeded in any given year is also referred to as the base flood and has a MRP of 100, which is also known as a 100-year flood. The term 100-year flood can be misleading; it is not the flood that will occur once every 100 years. Rather, it is the flood elevation that has a 1-percent chance of being equaled or exceeded each year. Therefore, the 100-year flood could occur more than once in a relatively short period of time or less than one time in 100 years (Dinicola 2014).

Location

This section describes the location information for hail, lightning, windstorms and high wind, thunderstorms, tornados, and hurricanes and tropical storms within Allegany County.

Hail

Hailstorms are most frequent in the southern and central plains states in the United States, where warm moist air off of the Gulf of Mexico and cold dry air from Canada collide, spawning violent thunderstorms. This area of the United States is known as hail alley and lies within the states of Texas, Oklahoma, Colorado, Kansas, Nebraska, and Wyoming. In New York State, hailstorms can occur anywhere within the State independently or during a tornado or thunderstorm event.

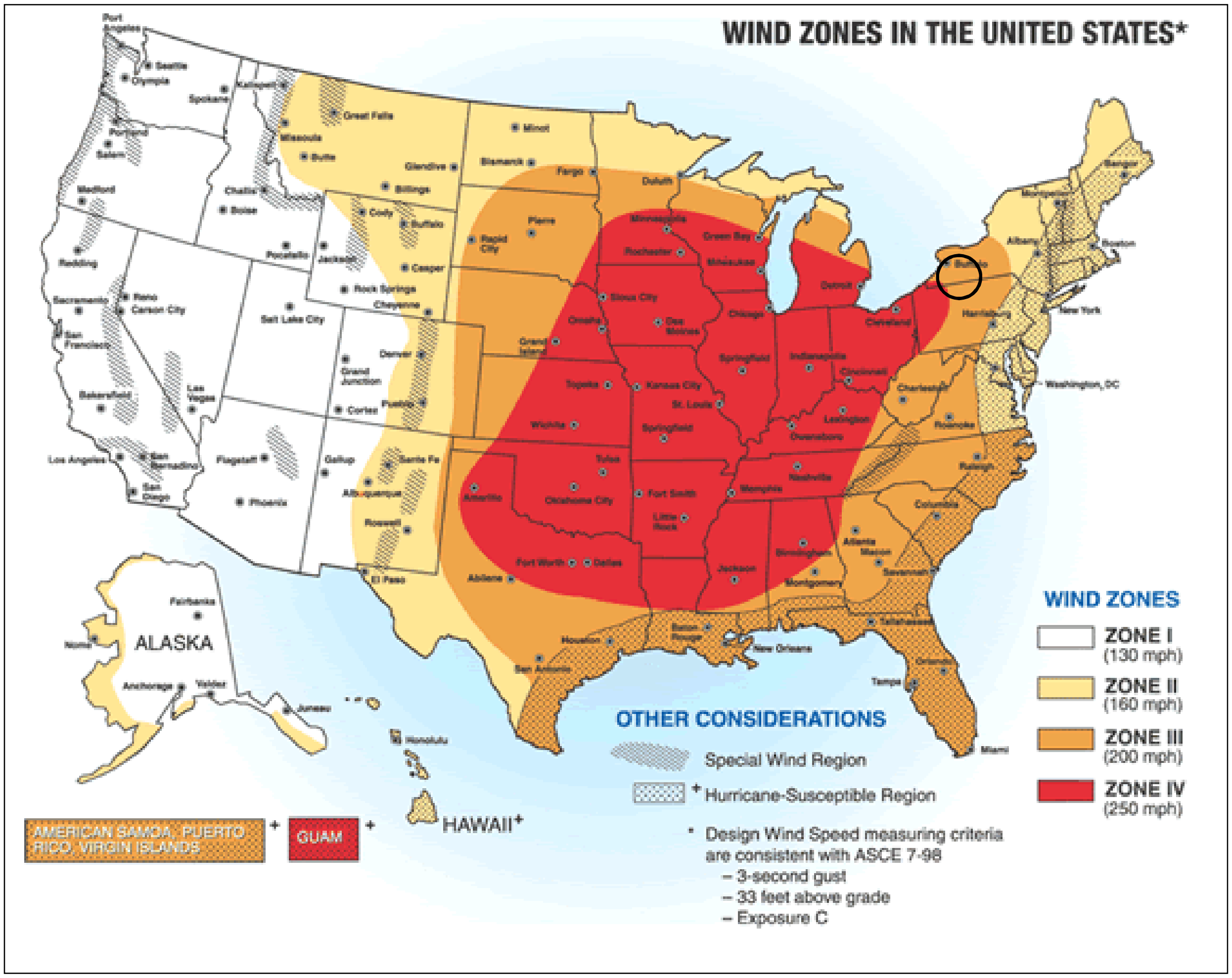
Lightning

Lightning is most often associated with thunderstorms and other severe storms. Although dry lightning strikes can occur without significant precipitation anywhere in the United States, they are more frequently associated with the western portion of the country. The New York City Office of Emergency Management (NYC OEM) notes that lightning strikes occur with moderate frequency in the State of New York, with 3.8 strikes occurring per square mile each year. In comparison, Florida experiences 20 strikes per square mile per year, and California experiences two strikes per square mile per year.

Windstorms and High Winds

All of Allegany County is subject to high winds from thunderstorms, hurricanes, tropical storms, tornadoes, and other severe weather events. According to the FEMA Winds Zones of the United States map, Allegany County is located in Wind Zone III, where wind speeds can reach up to 200 mph. Figure 5.4.9-2 illustrates wind zones across the United States, which indicate the impacts of the strength and frequency of wind activity per region. The information on the figure is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA.

Figure 5.4.9-2. Wind Zones in the United States



Source: FEMA 2012
Note: The black circle indicates the approximate location of Allegany County.

Thunderstorms

Thunderstorms affect relatively small localized areas rather than large regions, as winter storms and hurricanes can (NWS 2010). Thunderstorms can strike in all regions of the United States; however, they are most common in the central and southern states. The atmospheric conditions in these regions of the country are ideal for generating these powerful storms (NVRC 2006). As many as 40,000 thunderstorms are estimated to occur each day worldwide. The southeastern states have the most thunderstorms, with Florida having the highest number (80 to over 100 thunderstorm days each year) (NWS 2010). According to NOAA, Allegany County experiences between 20 and 40 thunderstorm days each year.

Tornado

Tornadoes have been documented in every state in the United States, and on every continent with the exception of Antarctica. Approximately 1,200 tornadoes occur in the United States each year, with the central portion of the country experiencing the highest number. Tornadoes can occur at any time of the year, with peak seasons at different times for different states (National Severe Storms Laboratory [NSSL] 2014).

New York State has a particular vulnerability to tornadoes. Since 1952, over 350 tornadoes ranging from F0 to F4 have occurred throughout the state (NYS DHSES 2014). Based on statistics from 1991 to 2010, New York State has experienced an average of 10 tornadoes annually (National Climatic Data Center [NCDC] 2013). Allegany County has experienced four tornadoes between 1960 and 2012 (NYS DHSES 2014).

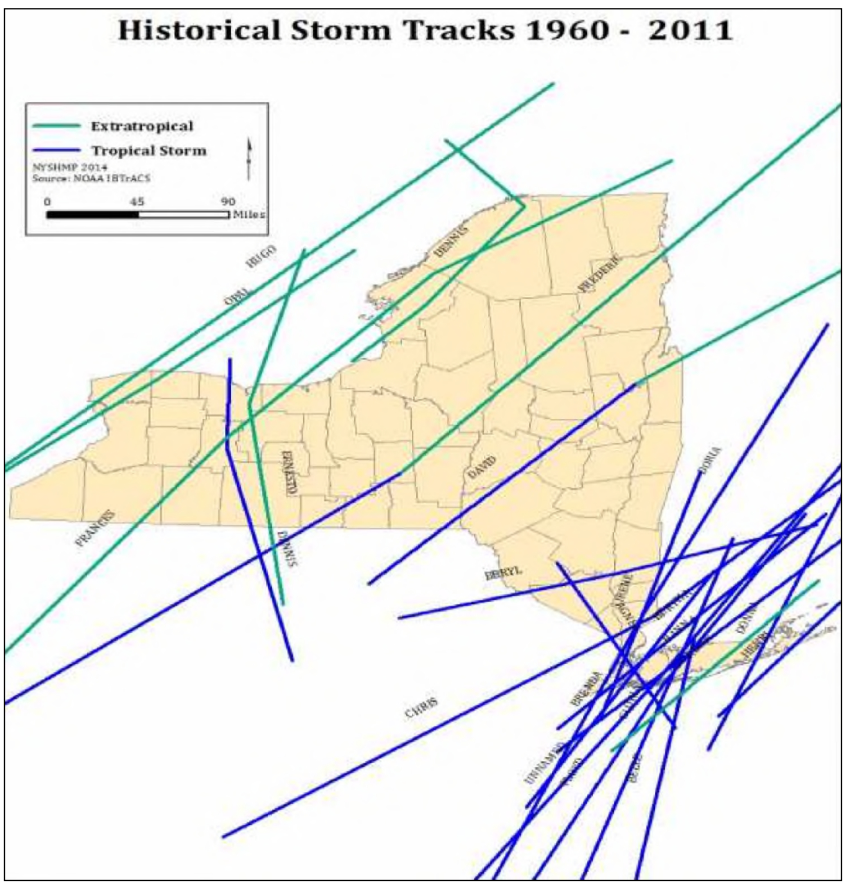
Hurricanes and Tropical Storms

Hurricane risk in the United States extends along the entire east coast, from Maine to Florida, the Gulf Coast, and Hawaii. Hurricane and tropical storms are the two major types of storms that generally impact New York State's marine coastline and adjacent inland areas (NYS DHSES 2014).

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 most likely period for hurricanes and tropical storms to impact New York State due to the cooling of the North Atlantic Ocean waters (NYS DHSES 2014).

Figure 5.4.9-3, from the 2014 New York State Hazard Mitigation Plan (NYS HMP), illustrates the tracks for storms between 1960 and 2011 for the 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 (NYS DHSES 2014).

Figure 5.4.9-3. Hurricane Tracks in New York State, 1960 to 2011



Source: NYS DHSES 2014

Allegany County is not frequently impacted by hurricanes, tropical storms, or tropical depressions. The County occasionally has experienced the direct and indirect landward effects associated with hurricanes and tropical storms in recent history. These storms are based on the Historical Hurricane Tracker, which include recent effects of Hurricane Agnes and Superstorm Sandy.

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with hurricane events throughout New York State and Allegany 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 Update.

Between 1954 and 2015, FEMA declared that New York State experienced 66 severe storm-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe storm, straight-line winds, coastal storm, hurricane/tropical storm, and tornado. Generally, these disasters cover a wide portion of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations. Of those events, the NYS HMP and FEMA indicate that Allegany County has been included in 16 declarations for severe storm-related events (FEMA 2015).

The U.S. Department of Agriculture (USDA) crop losses provide another indicator of the severity of previous events. Additionally, crop losses can have a significant impact on the economy by reducing produce sales and purchases. Such impacts may have long-term consequences, particularly if crop yields are low the following years as well. USDA records indicate that Allegany County has experienced crop losses from severe storm events. Table 5.4.9-7 provides details regarding crop losses in Allegany County according to USDA records.

Table 5.4.9-7. USDA Crop Losses from Severe Storms in Allegany County

Year	Crop Type	Cause of Loss	Losses
1989	All Other Crops	Excess Moisture/Precip/Rain	$ 20,313.00
1990	All Other Crops	Excess Moisture/Precip/Rain	$ 3,193.00
1990	All Other Crops	Wind/Excess Wind	$ 271.00
1994	All Other Crops	Wind/Excess Wind	$ 99.00
1994	All Other Crops	Excess Moisture/Precip/Rain	$ 891.00
1998	All Other Crops	Excess Moisture/Precip/Rain	$ 611.00
2000	All Other Crops	Excess Moisture/Precip/Rain	$ 10,881.00
2002	All Other Crops	Excess Moisture/Precip/Rain	$ 1,626.00
2003	All Other Crops	Excess Moisture/Precip/Rain	$ 17,950.00
2004	All Other Crops	Excess Moisture/Precip/Rain	$ 46,736.00
2006	All Other Crops	Excess Moisture/Precip/Rain	$ 13,466.00
2007	All Other Crops	Excess Moisture/Precip/Rain	$ 1,842.00
2008	All Other Crops	Hail	$ 2,217.00
2008	All Other Crops	Excess Moisture/Precip/Rain	$ 16,128.00
2009	All Other Crops	Excess Moisture/Precip/Rain	$ 51,101.00
2013	Corn	Excess Moisture/Precip/Rain	$86,258.00
2013	Processing Beans	Excess Moisture/Precip/Rain	$59,422.00
2013	Soybeans	Excess Moisture/Precip/Rain	$ 19,224.00
2014	Wheat	Excess Moisture/Precip/Rain	$ 18,903.00

Year	Crop Type	Cause of Loss	Losses
2014	Oats	Excess Moisture/Precip/Rain	$ 3,934.00
2014	Corn	Excess Moisture/Precip/Rain	$177,778.00
2014	Processing Beans	Excess Moisture/Precip/Rain	$101,862.00
2014	Soybeans	Excess Moisture/Precip/Rain	$71,333.00
2015	Wheat	Excess Moisture/Precip/Rain	$ 11,105.00
2015	Corn	Excess Moisture/Precip/Rain	$363,139.00
2015	Processing Beans	Excess Moisture/Precip/Rain	$ 20,870.00
2015	Soybeans	Excess Moisture/Precip/Rain	$130,111.00

Source: USDA 2016

For this 2017 HMP Update, known severe storm events that have impacted Allegany County between 1950 and 2016 are identified in Table 5.4.9-8. Records of these storm events often included impacts in other counties. The NYS HMP indicated that Allegany County has experienced 32 hailstorm events between 1960 and 2012, although only four hailstorms have occurred between 2010 and 2012. Those hailstorm events caused no injuries or deaths, but did cause over $118,023 in property damage and over $39,476 in crop damage. Although the NYS HMP only includes data up to 2012, other sources were used to determine whether additional hail events occurred after 2012. These events are also listed in Table 5.4.9-8.

Between 1960 and 2012, the County experienced 183 high wind events, leading to three (3) injuries, over $4.6 million in property damage, and over $91,000 in crop damage. Of those 204 events, 33 occurred between 2010 and 2012 (no fatalities or injuries, but $764,000 in property damage). The NYS HMP did not profile other types of severe storms or lightning events, and as such, County summary data are not available for these events (NYS DHSES 2014). As with hail events, however, other sources have been used to determine hazard events and frequency post-2012. With severe storm documentation for New York State and Allegany County being so extensive, not all sources have been identified or researched. Therefore, Table 5.4.9-8 may not include all events that have occurred in the County. Additionally, due to the extensive and diverse nature of event recording, the table below only includes records of storm events that resulted in financial impacts, particularly those exceeding $5,000 in property or crop loss.

Table 5.4.9-8. Severe Storm Events in Allegany County

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
September 3, 1993	Tornado	N/A	N/A	The tornado first touched down and uprooted or snapped a number of large trees. A large annex to a barn disintegrated as the tornado passed by. The debris was scattered downwind across a field. A pickup truck was moved about 75 feet down a road and tossed into a pole. The tornado then crossed a field and uprooted a few large trees that all fell in roughly the same direction. A nearby house sustained significant structural damage and the entire structure was shifted slightly off its foundation. The tornado crossed a field and a stand of large trees. Many of the trees were knocked down in a very "chopped up" pattern.
July 30, 1996	Tornado	N/A	N/A	A small tornado touched down during the evening hours. The tornado uprooted trees, tore portions of a metal roof off a barn, and ripped shingles off a mobile home.
February 22, 1997	High Wind	N/A	N/A	A strong cold front cross the region during the morning hours. Temperatures dropped 40 to 45 degrees with the passage of the front. The funnelling effect of the Great Lakes combined with rapid pressure rises behind the front to produce hazardous winds. Trees, power lines and poles were downed across the entire area. Hundreds of thousands were left without power. Reports of homes and autos damaged by the falling trees and limbs were numerous. The strong winds caused structure damage in some locations tearing off roofs and shingles, blowing out windows, and collapsing walls.
February 27, 1997	High Wind	N/A	N/A	Deep low pressure moved from Indiana to Ontario bringing high winds to the area. The strong winds downed trees and telephone and power lines. Power outages were reported throughout the area. Several cities and towns declared States of Emergency because of the prolonged lack of power. Windows were blown out of buildings. The strong winds caused structure damage in some locations tearing off roofs and sidings and collapsing walls. Homes and autos were damaged by falling limbs.
July 8, 1997	Tornado	N/A	N/A	A weak tornado touched down during the afternoon. Trees, up to two (2) feet wide, were snapped off, twisted and a few were uprooted.
July 18, 1997	Thunderstorm Wind	N/A	N/A	Thunderstorms developed ahead of a strong cold front and brought high winds and large hail to the region. The high winds downed trees and power lines and caused minor structural damage. Several fires were reported as a result of lightning strikes. The heavy rains that accompanied the storms resulted in minor urban flooding.
May 31, 1998	Thunderstorm Wind	N/A	N/A	An outbreak of severe storms began across the region during the early morning hours. The storms were particularly dangerous because of the speed that they were moving across the region--sometimes in excess of 60 mph. Most of the damage associated with these storms occurred from a combination of high winds and hail. There were reports of numerous trees and wires down as well as power outages. Tens of thousands were without power.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 2, 1998	Thunderstorm Wind	N/A	N/A	Severe thunderstorms swept across the entire region during the late afternoon and evening hours. The storms produced hailstones up to 1.5". Although the stones were not excessively large, what was unusual for the area was the number and areal coverage of the reported hail. It was the first time three-quarter inch hail had been observed at the Buffalo Airport since record keeping began there. In addition to the large amount of hail, the thunderstorms produced damaging winds which downed trees and power lines and poles.
August 24, 1998	Hail	N/A	N/A	Severe thunderstorms moved across the western southern tier of the state during the morning hours. The thunderstorms produced hail up to three-quarters of an inch and strong winds which downed trees and power lines.
September 7, 1998	Thunderstorm Wind	N/A	N/A	Thunderstorms developed during the overnight along old thunderstorm boundaries. The severe storms produced 3/4" hail and damaging winds. The strong winds downed trees and power lines.
July 3, 1999	Thunderstorm Wind	N/A	N/A	Severe thunderstorms cross the region during the late afternoon hour. The thunderstorms produced heavy downpours, up to three inches in some spots, strong winds and large hail. The heavy downpours resulted in localized poor drainage flooding. The strong winds downed trees and power lines throughout the region. Structure damage was also reported.
July 31, 1999	Thunderstorm Wind	N/A	N/A	Violent thunderstorms ripped across western New York and the Finger Lakes region during the evening hours. The strong thunderstorms downed trees and power lines and left hundreds of thousands without power. Several roads were blocked by fallen debris. Several of the falling trees caused damage to houses and automobiles.
October 13, 1999	Thunderstorm Wind	N/A	N/A	A strong cold front crossed the area. The thunderstorms that accompanied the front produced damaging winds and large hail. The winds downed trees and power lines. About 10,000 customers lost their power.
May 10, 2000	Hail	N/A	N/A	Thunderstorms rolled in off the Great Lakes producing large hail and damaging winds. In some locations the steady fall of hail was enough to whiten the ground. The shower of hail stripped leaves from trees. In addition, the thunderstorms produced localized heavy rains which resulted in poor drainage flooding.
August 9, 2000	Thunderstorm Wind	N/A	N/A	Numerous thunderstorms crossed the western southern tier and Genesee valley during the evening hours. The thunderstorm winds downed trees and power lines. Thousands were without electricity. The torrential rains accompanying the thunderstorms, coming just a few days after earlier heavy rains, resulted in flash flooding. In Allegany county, Routes 23, 27, 36 and 3 were closed for days.
June 12, 2001	Thunderstorm Wind	N/A	N/A	Severe thunderstorms crossed Allegany county during the afternoon hours. Several houses were damaged and two cars were flattened.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
October 21, 2001	Thunderstorm Wind	N/A	N/A	A line of thunderstorms moved across the western southern tier and parts of the Finger Lakes region during the late afternoon hours. Hail up to 1" in diameter was also reported with the storms. In some spots, the hail covered the ground and the high winds drifted the hail to a depth of one to two feet.
March 9, 2002	High Wind	N/A	N/A	Strong winds accompanied and followed the passage of a cold front. The damaging winds affected the entire area, downing trees and power lines and causing some structural damage. Nearly 100,000 customers completely lost power with thousands of others experiencing brief power outages.
April 28, 2002	Tornado	N/A	N/A	Thunderstorms developed across the eastern Great Lakes region during the afternoon hours. The thunderstorms produced hail up to 1.25" in diameter. The thunderstorms spawned two tornadoes. Winds were estimated between 70 and 135 mph.
June 26, 2002	Thunderstorm Wind	N/A	N/A	Thunderstorms developed in a warm, moist, unstable flow during the late morning and afternoon hours. The strong thunderstorms produced damaging wind gusts that downed trees and power lines.
June 27, 2002	Thunderstorm Wind	N/A	N/A	Thunderstorms developed ahead of an approaching cold front. The thunderstorms produced damaging winds which gusted to near 70 mph. Damage consisted mainly of downed trees and power lines, although some structural damage occurred.
July 28, 2002	Thunderstorm Wind	N/A	N/A	Downburst winds accompanying thunderstorms across the southern tier and parts of the Finger Lakes produced isolated downed trees and power lines. Thunderstorms re-developed during the afternoon and evening hours. As many as 15,000 were without power in the southern tier for several hours.
September 29, 2005	Thunderstorm Wind	N/A	N/A	A strong cold front crossed the region during the early morning hours. The thunderstorms accompanying the front produced damaging winds that downed trees and power lines. At the peak of the storms, over 30,000 customers were without power. Falling trees damaged homes and/or automobiles.
February 17, 2006	High Wind	N/A	N/A	Low pressure deepened as it tracked northeast into southern Ontario. The strong winds associated with the low downed trees and power lines throughout western New York and the north country. Damage from falling trees to buildings and automobiles was extensive. Over 150,000 were left without power during the peak of the storm.
August 25, 2007	Thunderstorm Wind	N/A	N/A	A cold front crossed the region during the early evening hours. Thunderstorms accompanying the front produced damaging winds, estimated approaching 60 mph, which downed trees and power lines.
January 30, 2008	High Wind	N/A	N/A	A powerful cold front crosses western New York and was followed by very strong west to southwest winds. Sustained winds increased to 30 to 45 mph with gusts measured to 80 mph at the peak of the storm. Trees and power lines were downed by the strong winds. Utility companies reported close to 100,000 customers without power in locations scattered throughout region. Several homes and automobiles were damaged by falling trees and limbs.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
September 14, 2008	High Wind	N/A	N/A	The low center that was the remnants of Hurricane Ike reached the lower Great Lakes region during the late evening of the 14th and brought high winds to the area as it lifted from Indiana across southern Ontario. Wind gusts were measured to 66 mph. The winds downed trees and power lines throughout the area. The wet soil conditions contributed to the number of downed trees. Debris blocked many streets and highways. There were numerous reports of homes, building and automobiles being damaged by fallen trees.
June 26, 2009	Thunderstorm Wind	N/A	N/A	An upper level disturbance brought a round of thunderstorms to the Finger Lakes region during the early afternoon hours. Hail up to an inch and a half was reported and the thunderstorms winds downed trees and power lines. Several thousand customers lost power because of the storm. Poor drainage flooding was reported.
August 9, 2009	Tornado	N/A	N/A	A massive convective complex moving south across the region produced a tornado in Allegany County.
May 8, 2010	High Wind	N/A	N/A	Deep low pressure passed over western New York with its trailing cold front rapidly sweeping east across the region. Winds increased within a few hours of the approaching front to gust speeds of 60 to 65 mph. Tens of thousands were left without power. $100,000 in property damage was reported.
April 16, 2011	High Wind	N/A	N/A	An area of low pressure moved across the eastern Great Lakes region. The system brought strong winds to the area. Wind gusts were measured to 67 mph. The strong winds downed trees and power lines. Utilities reported several thousand customers without power during the evening hours. $10,000 in property damage was reported.
April 26, 2011	Hail	N/A	N/A	A line of showers and thunderstorms crossed the area during the evening hours. The thunderstorms were accompanied by strong winds, large hail and intense rains.
April 27, 2011	Thunderstorm Wind	N/A	N/A	Showers and thunderstorms accompanied the passage of a cold front across the region. The thunderstorms winds downed trees and power lines. Several hundred customers were without power. $25,000 in property damage was reported.
May 29, 2011	Thunderstorm Wind	N/A	N/A	A slow moving cold front crossed the region during the late evening and early overnight hours. The thunderstorms produced wind gusts measured to 65 mph. Numerous localities across the region report trees and power lines downed. $18,000 in property damage was reported.
January 17, 2012	High Wind	N/A	N/A	Low pressure moved across southern Ontario and pulled a strong cold front across the region during the evening hours. Thunderstorms which accompanied the front produced wind gusts up to around 70 mph. The strong winds downed trees and power lines and poles. Power outages were scattered throughout the region with utilities reporting several thousand without power at its worse. $70,000 in property damage was reported.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
July 31, 2012	Thunderstorm Wind	N/A	N/A	While a slow moving cold front eased south across southern Ontario, a 30-mile wide band of showers and thunderstorms developed over Western New York. Initially the thunderstorms produced heavy rains. The thunderstorms continued to strengthen as they moved into the southern tier and eastern Lake Ontario Region. Reports of downed trees and wires were scattered throughout the region. $10,000 in property damage was reported.
September 8, 2012	Thunderstorm Wind	N/A	N/A	A line of thunderstorms developed along a pre-frontal trough and moved across the entire region from west to east from mid-morning through early afternoon. The thunderstorm winds downed trees and power lines as the fast moving line swept across the area. Power poles were snapped in some cases and power outages were reported throughout the area. Utilities reported tens of thousands of customers without power. $10,000 in property damage was reported.
October 29, 2012	High Wind	N/A	N/A	Remnants of Hurricane Sandy brought strong winds and heavy rains to western and north central New York. Rainfall amounts of two to five inches were measured across the area with some area creeks reaching bankful. The high winds downed trees and power lines throughout the region. Wind gusts were measured to 60 mph. Tree damage was greater than usual with such wind speeds because of saturated ground and northeast winds - opposite of the normal prevailing southwest direction. Utilities reported tens of thousands of customers without power across the entire region. Gusts ranged from 45 to 60 mph. $150,000 in property damage was reported.
January 20, 2013	High Wind	N/A	N/A	A deepening storm system moved across the Upper Great lakes. The system brought strong, damaging winds to the entire region late Saturday night into Sunday (20th-21st). Trees, power poles and wires were brought down by the winds. Numerous roads were blocked by fallen trees, wires and debris. Some structural damage was also reported. $15,000 in property damage was reported.
June 17, 2014	Thunderstorm Wind	N/A	N/A	Scattered showers and thunderstorms developed in a warm, humid air mass during the afternoon hours. These were followed by a large area of showers and thunderstorms associated with low pressure moving across the Great Lakes into southern Ontario and then Quebec. Several of the thunderstorms produced strong, damaging winds. Damage was mainly reported as downed trees and wires however there were some reports of structural and other damage. $15,000 in property damage was reported.
July 13, 2014	Thunderstorm Wind	N/A	N/A	Thunderstorms developed during the afternoon hours ahead of an approaching cold front. An isolated thunderstorm produced damaging winds as it crossed Allegany County. $10,000 in property damage was reported.
June 23, 2015	Thunderstorm Wind	N/A	N/A	An area of showers and thunderstorms moved across Lake Erie into the western southern tier. The thunderstorms produced strong winds that downed trees and power lines. Several of the downed trees damage structures and cars. Some roads were temporarily blocked by debris. $20,000 in property damage was reported.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
September 9, 2015	Thunderstorm Wind	N/A	N/A	A cold front crossed New York State during the late morning/early afternoon hours. The thunderstorms that accompanied the front became stronger as the line approached the Genesee Valley and cross the Finger Lakes Region. The thunderstorm winds downed trees and power lines. Several roads were blocked. $30,000 in property damage was reported.

Sources: *NOAA-NCDC 2015; FEMA 2015;*
Notes:
FEMA *Federal Emergency Management Agency*
mph *miles per hour*

Probability of Future Occurrences

Predicting future severe storm events in a constantly changing climate has proven to be a difficult task. Predicting extremes in New York State is difficult because the region's geographic location is positioned roughly halfway between the equator and the North Pole, and it is exposed to both cold and dry airstreams from the south. The interaction between these opposing air masses often leads to turbulent weather across the region (Keim 1997).

Allegany County is predicted to continue experiencing direct and indirect impacts of severe storms annually. These storms may induce secondary hazards such as flooding, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, transportation delays, accidents, and inconveniences.

Table 5.4.9-9 summarizes data regarding the probability of occurrences of severe storm events in Allegany County. Based on historic occurrences, thunderstorm events are the most common in Allegany County, followed by hail events. However, the information used to calculate the probability of occurrences is based solely on NOAA-NCDC storm events database results.

Table 5.4.9-9. Probability of Occurrence of Severe Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2016	Rate of Occurrence	Recurrence Interval (in years)	Probability of Event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Hail	24	0.36	2.75	0.36	36.4%
Hurricane / Tropical Storm	0	0	0	0	0%
Tornado	8	0.12	8.25	0.12	12.1%
High Wind	20	0.30	3.3	0.30	30.3%
Thunderstorm Wind	170	2.58	0.39	2.56	100%*
Lightning	1	0.01	66	0.01	1.5%
Total	**223**	**3.38**	**0.29**	**3.45**	**100%***

Source: NOAA-NCDC 2015
Notes: Probability was calculated using the available data provided in the NOAA-NCDC storm events database.
** Any probability greater than 100% was rounded to 100%.*

In Section 5.3, the identified hazards of concern for Allegany 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 Planning Partnership, the probability of occurrence for severe storms in the county is considered "frequent" (likely to occur more than once every 25 years, as presented in Table 5.3-3).

Climate Change Impacts

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue to grow. Impacts related to increasing temperatures and rising sea levels are already being felt throughout the state. ClimAID: The Integrated Assessment for Effective Climate Change in New York State (ClimAID) was undertaken to provide decision-makers with information on the state's vulnerability to climate change, and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (New York State Energy Research and Development Authority [NYSERDA] 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Allegany County is part of geological Region 3, the Southern Tier. Some of the issues in this region that are affected by climate change include more frequent and intense heat waves and increased frequency of intense precipitation events (NYSERDA 2011).

Temperatures are expected to increase throughout the State, by 2.0 to 3.4 ºF by the 2020s, 4.1 to 6.8 ºF by the 2050s, and 5.3 to 10.1 ºF by the 2080s. The lower ends of these ranges are for lower greenhouse gas emissions scenarios, and the higher ends of these ranges are for higher emissions scenarios. The increasing temperatures could lead to a longer growing season (by about one [1] month), more intense summers, and milder winters.

Annual average precipitation is projected to increase by up to one (1) to eight (8) percent by the 2020s, by three (3) to 12 percent by the 2050s, and four (4) to 15 percent by the 2080s. During the winter months, additional precipitation will most likely occur in the form of rain, and with the possibility of slightly reduced precipitation projected for the late summer and early fall. Northern parts of the New York State are expected to see the greatest increases in precipitation (NYSERDA 2014).

The projected increase in precipitation is expected to occur in the form of heavy downpours and less through light rains. The increase in heavy downpours has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways, and transportation hubs; and increase delays and hazards related to extreme weather events. Increasing air temperatures intensify the water cycle by increasing evaporation and precipitation, which can cause an increase in rain totals during storm events and result in longer dry periods in between those events. These changes can have a variety of effects on the State's water resources.

Over the past 50 years, heavy downpours have increased and this trend is projected to continue, contributing to localized flash flooding in urban areas and hilly regions. Flooding has the potential to increase pollutants in the water supply and inundate wastewater treatment plants and other vulnerable facilities located within floodplains. Less frequent rainfall during the summer months may impact the ability of water supply systems. Increasing water temperatures in rivers and streams will affect aquatic health and reduce the capacity of streams to assimilate effluent wastewater treatment plants.

Total precipitation amounts have slightly increased in the northeastern states by approximately 3.3 inches over the last 100 years. Number of 2-inch rainfall events over a 48-hour period has also increased since the 1950s (a 67-percent increase). The number and intensity of extreme precipitation events are increasing in New York State as well. More rain heightens the danger of localized flash flooding, streambank erosion, and storm damage (Cornell University College of Agriculture and Life Sciences 2011).

5.4.9.2 Vulnerability Assessment

To understand risk, a community must evaluate its assets that are exposed and vulnerable within the identified hazard area. For the severe storm hazard, all of Allegany County is has been identified as the hazard area. Therefore, all assets within the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are potentially vulnerable. This section addresses the following factors to evaluate and estimate the potential impacts of severe storms on the County:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on (1) life, safety and health of 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

Overview of Vulnerability

The high winds and air speeds of a hurricane or any severe storm often 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 storms evaluates available data for a range of storms included in this hazard category.

The entire inventory of the County is at risk of being damaged or lost due to impacts from severe wind storms. Certain areas, infrastructure, and types of buildings are at greater risk than others because of their proximity to falling hazards and 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, critical facilities, and the economy are presented below, following a summary of the data and methodology used.

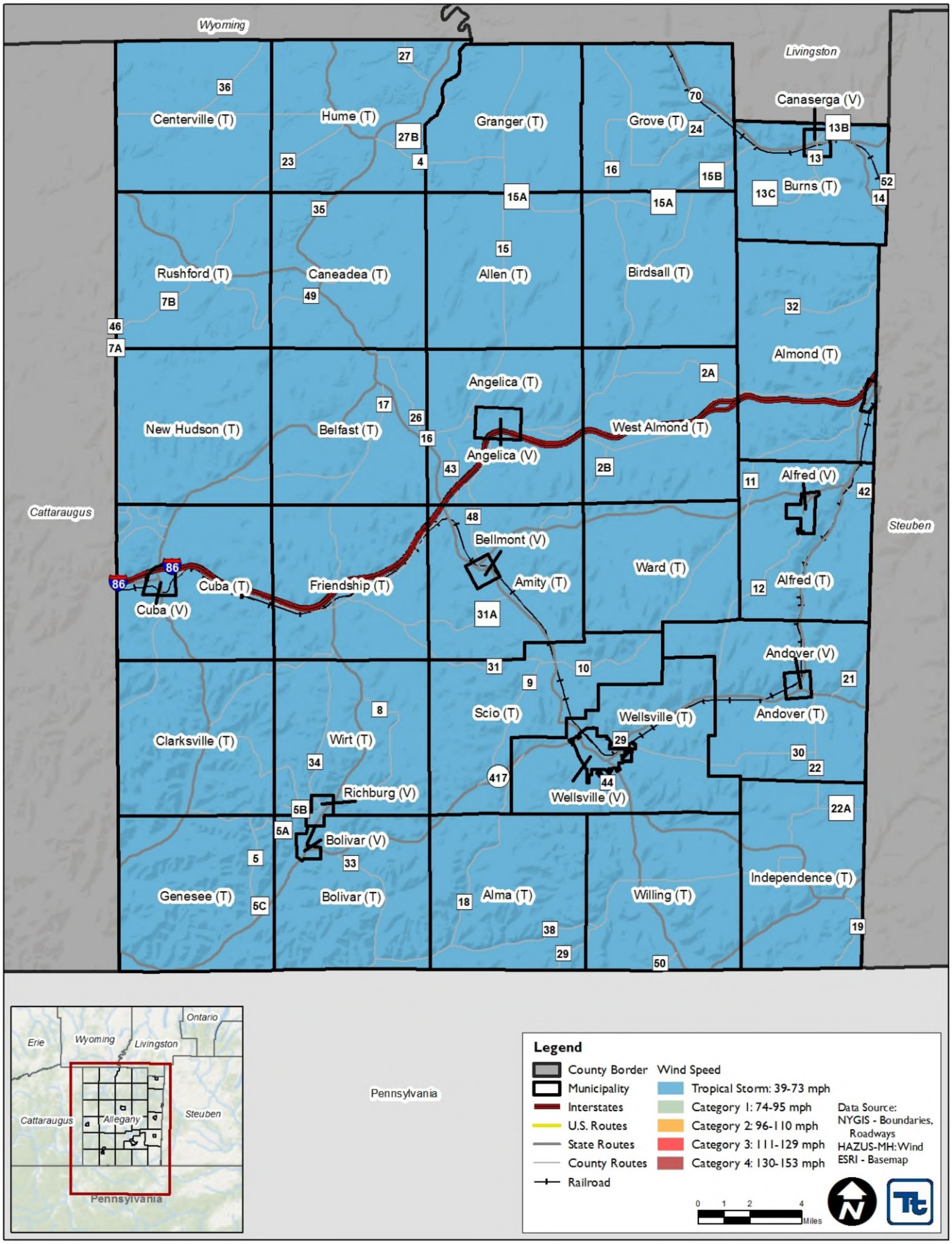
Data and Methodology

After reviewing historic data, FEMA's Hazards U.S-Multi Hazard (HAZUS-MH) methodology and model were used to analyze the severe storm hazard for Allegany County. Data used to assess this hazard include data available in the HAZUS-MH hurricane model, professional knowledge, information provided by the Hazard Mitigation Team, and input from the public.

A probabilistic HAZUS-MH wind model was run for Allegany County for the 100- and 500-year MRP events. The maximum peak gust wind speeds for the 100-year MRP event were less than 39 mph (tropical storm). The results for the 500-year MRP hurricane event are shown in Figure 5.4.9-4, which illustrates the HAZUS-MH maximum peak gust wind speeds (48-54 mph, tropical storm) that can be anticipated in the study area associated with the 500-year MRP hurricane event. Due to FEMA-known issues with HAZUS-MH version 3.0, the estimated hurricane track for the 500-year is not available for display.

HAZUS-MH contains data on historic hurricane events and wind speeds, in addition to 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 events (severe wind impacts). Updated critical facility inventories and general building stock data were used in this evaluation. The model was run at the tract level for the County.

Figure 5.4.9-4. Wind Speeds for the 500-Year Mean Return Period Event



Source: HAZUS-MH v.3.0

Impact on Life, Health, and Safety

The impact of a severe storm on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. The entire county's population (population of 48,946 people, according to U.S. Census 2010) is assumed to be exposed to this storm hazard.

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. 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. HAZUS-MH currently estimates that no people will be displaced and that no people will require temporary shelter due to either a 100-year or a 500-year MRP event.

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. The elderly population is considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention, which may not be available due to isolation during a storm event. Section 4 provides for the statistics for these populations.

Impact on General Building Stock

After considering the population exposed to the severe storm hazard in Allegany County, the general building stock replacement value exposed to and damaged by 100- and 500-year MRP events was examined. Wind-only impacts from a severe storm are reported based on the probabilistic hurricane runs in HAZUS-MH. Potential damage is the modeled loss that could occur to the exposed inventory, including damage to structural and content value based on the wind-only impacts associated with a hurricane (using the methodology described in Section 5.1 of this HMP).

The entire county's general building stock is assumed to be exposed to the severe storm wind hazard (greater than $9.2 billion in structure only). Expected building damage was evaluated by HAZUS-MH across the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 5.4.9-10 summarizes the definition of the damage categories.

Table 5.4.9-10. 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
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 cover, with no or very limited water penetration.	≤ 2%	No	No	No	No	No
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	< Five (5) Impacts	No	No
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%	> the larger of 20% & 3 and ≤ 50%	One (1) to Three (3) Panels	Typically five (5) to 10 Impacts	No	No

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	> 50%	> one and ≤ the larger of 20% & 3	> three (3) and ≤ 25%	Typically 10 to 20 Impacts	No	No
Total 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 the profile, HAZUS-MH estimates the 100-year MRP peak gust wind speeds for Allegany County to be less than 39 mph. For the 100-year MRP event, HAZUS-MH estimates $0 in structure damage.

HAZUS estimates the 500-year MRP peak gust wind speeds for Allegany County to range from 48 to 54 mph. This equates to a tropical storm and to less than $140,000 in damage to the general building stock (structure only), a small percentage of the County's total building inventory. The residential buildings are estimated to experience all of the damage. Table 5.4.9-11 summarizes the building damage (structure only) estimated for the 100- and 500-year MRP wind-only events by occupancy class.

Table 5.4.9-11. Estimated Building Replacement Value (Structure Only) Damaged by the 100-Year and 500-Year Mean Return Period Hurricane-Related Winds for All Occupancy Classes

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages		Percent of Total Building Replacement Cost Value	
		100-Year	500-Year	100-Year	500-Year
Alfred (T)	$235,833,436	$0	$4,125	0%	<1%
Alfred (V)	$344,568,810	$0	$2,313	0%	<1%
Allen (T)	$105,698,559	$0	$3,043	0%	<1%
Alma (T)	$165,632,005	$0	$7,099	0%	<1%
Almond (T)	$202,093,532	$0	$325	0%	<1%
Almond (V)	$86,607,225	$0	$0	0%	0%
Amity (T)	$214,848,732	$0	$8,896	0%	<1%
Andover (T)	$150,580,260	$0	$3,497	0%	<1%
Andover (V)	$211,214,385	$0	$1,660	0%	<1%
Angelica (T)	$124,958,517	$0	$2,680	0%	<1%
Angelica (V)	$178,634,415	$0	$3,310	0%	<1%
Belfast (T)	$341,221,848	$0	$7,731	0%	<1%
Belmont (V)	$242,397,843	$0	$140	0%	<1%
Birdsall (T)	$75,747,446	$0	$1,015	0%	<1%
Bolivar (T)	$171,980,462	$0	$2,217	0%	<1%
Bolivar (V)	$256,381,192	$0	$1,600	0%	<1%
Burns (T)	$113,642,307	$0	$0	0%	0%
Canaseraga (V)	$121,248,846	$0	$0	0%	0%
Caneadea (T)	$323,103,002	$0	$11,662	0%	<1%
Centerville (T)	$139,748,391	$0	$2,772	0%	<1%

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages		Percent of Total Building Replacement Cost Value	
		100-Year	500-Year	100-Year	500-Year
Clarksville (T)	$191,915,647	$0	$641	0%	<1%
Cuba (T)	$296,679,765	$0	$1,939	0%	<1%
Cuba (V)	$369,424,521	$0	$22	0%	<1%
Friendship (T)	$410,747,777	$0	$4,888	0%	<1%
Genesee (T)	$239,176,109	$0	$4,038	0%	<1%
Granger (T)	$118,474,228	$0	$5,368	0%	<1%
Grove (T)	$131,721,806	$0	$1,074	0%	<1%
Hume (T)	$374,787,783	$0	$6,765	0%	<1%
Independence (T)	$200,727,981	$0	$3,160	0%	<1%
New Hudson (T)	$161,142,826	$0	$1,786	0%	<1%
Richburg (V)	$73,809,245	$0	$59	0%	<1%
Rushford (T)	$429,785,920	$0	$5,860	0%	<1%
Scio (T)	$277,826,609	$0	$6,021	0%	<1%
Ward (T)	$75,125,267	$0	$3,332	0%	<1%
Wellsville (T)	$471,554,227	$0	$12,573	0%	<1%
Wellsville (V)	$1,207,001,334	$0	$6,556	0%	<1%
West Almond (T)	$94,914,093	$0	$1,735	0%	<1%
Willing (T)	$204,894,983	$0	$5,791	0%	<1%
Wirt (T)	$143,336,938	$0	$2,823	0%	<1%
Allegany County (Total)	**$9,279,188,271**	**$0**	**$138,512**	**0%**	**<1%**

Source: Allegany County 2016; Hazus-MH 3.0

Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. The damage counts include buildings damaged at all severity levels from minor damage to total destruction. Total dollar damage reflects the overall impact to buildings at an aggregate level.

Impact on Critical Facilities

HAZUS-MH estimates the probability that critical facilities (such as medical facilities, fire and emergency medical services, police, Emergency Operation Centers (EOC), schools, and user-defined facilities such as shelters and municipal buildings) may sustain damage as a result of 100-year and 500-year MRP wind-only events. Additionally, HAZUS-MH estimates the loss of use for each facility in number of days. HAZUS-MH estimates there is a 0 percent chance that critical facilities in Allegany County will experience minor damage; and continuity of operations at these facilities will not be interrupted (no loss of use is estimated) as a result of the 100- or 500-year MRP events.

At this time, HAZUS-MH 3.0 does not estimate losses to transportation lifelines and utilities as part of the hurricane model. Transportation lifelines are not considered particularly vulnerable to the wind hazard; they are more vulnerable to cascading effects such as flooding and falling debris. Impacts to transportation lifelines affect both short-term (for example, evacuation activities) and long-term (for example, day-to-day commuting) transportation needs.

Utility structures could suffer damage associated with falling tree limbs or other debris, resulting in the loss of power, which can impact business operations and can impact heating or cooling provision to citizens. Interruptions in heating or cooling utilities can affect populations such the young and elderly, who are particularly vulnerable to temperature-related health impacts.

Impact on Economy

Severe storms also impact the economy, specifically contributing to loss of business function (for example, tourism and recreation industries), damage to inventory, relocation costs, wage loss, and rental loss due to the repair or 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 a building, which is reported in the “Impact on General Building Stock” section discussed earlier in this section. Business interruption losses include losses associated with the inability to operate a business because of the wind damage sustained during a storm or the temporary living expenses for those displaced from their home because of an event.

For the 100-year MRP wind event, HAZUS-MH estimates $0 in business interruption losses or inventory losses. For the 500-year MRP wind-only event, HAZUS-MH estimates less than $500 in business interruption losses for Allegany County, which includes loss of income, relocation costs, rental costs, and lost wages. Further, HAZUS-MH estimates $0 in loss of inventory.

HAZUS-MH 3.0 also estimates the amount of debris that may be produced a result of the 100- and 500-year MRP wind events. HAZUS-MH 3.0 estimates that no debris will be generated as a result of the 500-year MRP wind events. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the HAZUS-MH Hurricane User Manual:

> *The Eligible Tree Debris columns provide estimates of the weight and volume of downed trees that would likely be collected and disposed at public expense. As discussed in Chapter 12 of the HAZUS-MH Hurricane Model Technical Manual, the eligible tree debris estimates produced by the Hurricane Model tend to underestimate reported volumes of debris brought to landfills for a number of events that have occurred over the past several years. This indicates that that there may be other sources of vegetative and non-vegetative debris that are not currently being modeled in HAZUS. For landfill estimation purposes, it is recommended that the HAZUS debris volume estimate be treated as an approximate lower bound. Based on actual reported debris volumes, it is recommended that the HAZUS results be multiplied by three to obtain an approximate upper bound estimate. It is also important to note that the Hurricane Model assumes a bulking factor of 10 cubic yards per ton of tree debris. If the debris is chipped prior to transport or disposal, a bulking factor of 4 is recommended. Thus, for chipped debris, the eligible tree debris volume should be multiplied by 0.4’.*

Table 5.4.9-12 summarizes debris production estimates for 500-year MRP wind events.

Table 5.4.9-12. Debris Production for 500-Year Mean Return Period Wind Events

Municipality	Brick and Wood (tons)	Concrete and Steel (tons)	Tree (tons)	Eligible Tree Volume (cubic yards)
Alfred (T)	0	0	0.0	0.0
Alfred (V)	0	0	0.0	0.0
Allen (T)	0	0	0.0	0.0
Alma (T)	0	0	275.0	114.0
Almond (T)	0	0	0.0	0.0
Almond (V)	0	0	0.0	0.0
Amity (T)	0	0	37.0	44.3
Andover (T)	0	0	0.0	0.0
Andover (V)	0	0	0.0	0.0
Angelica (T)	0	0	5.0	5.4
Angelica (V)	0	0	1.0	1.7
Belfast (T)	0	0	73.0	66.1
Belmont (V)	0	0	4.0	45.4
Birdsall (T)	0	0	0.0	0.0
Bolivar (T)	0	0	283.0	105.2
Bolivar (V)	0	0	0.0	7.7
Burns (T)	0	0	0.0	0.0
Canaseraga (V)	0	0	0.0	0.0
Caneadea (T)	0	0	41.0	83.4
Centerville (T)	0	0	122.0	38.1
Clarksville (T)	0	0	9.0	39.4
Cuba (T)	0	0	41.0	25.3
Cuba (V)	0	0	0.0	0.0
Friendship (T)	0	0	25.0	22.2
Genesee (T)	0	0	236.0	79.3
Granger (T)	0	0	2.0	4.5
Grove (T)	0	0	0.0	0.0
Hume (T)	0	0	58.0	37.6
Independence (T)	0	0	0.0	0.0
New Hudson (T)	0	0	84.0	43.5
Richburg (V)	0	0	0.0	1.6
Rushford (T)	0	0	21.0	19.4
Scio (T)	0	0	264.0	116.6
Ward (T)	0	0	0.0	0.0
Wellsville (T)	0	0	7.0	13.9
Wellsville (V)	0	0	6.0	30.5
West Almond (T)	0	0	0.0	0.0
Willing (T)	0	0	0.0	0.0
Wirt (T)	0	0	137.0	70.4
Allegany County (Total)	**0**	**0**	**1,731.0**	**1,015.6**

Source: HAZUS-MH 3.0

Future Growth and Development

As discussed and illustrated in Section 4, areas targeted for future growth and development have been identified across Allegany County. Any areas of growth could be potentially impacted by the severe storm hazard because the entire County is exposed and vulnerable to the wind hazard associated with severe storms.

Additional Data and Next Steps

Over time, Allegany County will obtain additional data to support the analysis of this hazard. Such data may include additional details on past hazard events and impacts; specific building information, such as type of construction; and details on protective features (for example, hurricane straps). Information on the age or year built of particular buildings or infrastructure would also be helpful in future analysis of this hazard. Mitigation strategies to reduce vulnerability to severe storms are provided in Section 6 (Volume 1) and Section 9 (Volume II) of this HMP.