5.4.8 Severe Storm

This section provides profile information including description, location, extent, previous occurrences and losses, probability of future occurrences, and climate change impacts, as well as the vulnerability assessment for the severe storm hazard in Genesee County.

5.4.8.1 Hazard Profile

Description

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

Hail

Hail forms inside a thunderstorm where there are strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32°F or colder. As the frozen droplet begins to fall, it 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 inches in diameter (National Weather Service [NWS] 2010).

High Winds

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; Robinson 2013). Wind begins with differences in air pressures. It is rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth (Ilicak 2005). High winds have the potential to down trees, tree limbs, and power lines, which lead to widespread power outages and damage to residential and commercial structures throughout Genesee County. High winds are often associated by other severe storm events such as thunderstorms, tornadoes, hurricanes, and tropical storms (all discussed further in this section). Table 5.4.8-1 provides the wind descriptions used by the NWS.

Table 5.4.8-1. NWS Wind Descriptions

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

Source: NWS 2010
mph Miles per hour

Thunderstorms

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

Lighting is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. It ranks as one of the top weather killers in the United States and kills approximately 50 people and injures hundreds 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 utility losses, such as water, phone and electricity. Lightning can damage homes and injure people. In the United States, an average of about 300 people are injured and 50 people are killed by lightning each year. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the U.S., with approximately 10 percent of them classified as severe. During the warm season, thunderstorms are responsible for most of the rainfall.

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 300 mph. Damage paths can be greater than one 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. The average speed of a tornado is 30 mph but may vary from nearly stationary to 70 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997; NWS 2010).

Hurricanes/Tropical Storms

A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles per hour (mph). 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 Association [NOAA] 1999).

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. 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 Genesee County's location, storm surge is not a concern for the County and has not been detailed in this profile.

Extent

Hail

The severity of hail is measured by duration, hail size, and geographic extent. All of these factors are directly related to thunderstorms, which create hail. There is wide variation in the severity components of hail, 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 [NYS] Division of Homeland Security and Emergency Services [DHSES] 2014). Table 5.4.8-2 lists the different sizes of hail compared to real-world objects.

Table 5.4.8-2. Hail Size

Description	Diameter (in inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.88

Description	Diameter (in inches)
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

Windstorms and High Winds

Table 5.4.8-3 provides the NWS descriptions of winds during wind-producing events.

Table 5.4.8-3. 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 hour or longer, or wind gusts of 58 mph or greater for any duration
- *Wind Advisories* are issued when sustained winds of 30 to 39 mph are forecast for one hour or longer, or wind gusts of 46 to 57 mph for any duration (NWS 2015).

Lightning

As with hail, lightning can be produced by a wide variety of situations, but it is most often associated with moderate to severe thunderstorms. As noted earlier, 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 upon 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 (i.e., persons, animals, 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.

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 1 inch in diameter or greater. A warning will include where the storm was located, what municipalities will 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; NWS 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 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, the NWS will keep the public informed on what is happening in the watch area and also let the public know when the watch has expired or been cancelled (NWS 2009; NWS 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 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. This used to be the standard measurement for rating the strength of a tornado. The F-Scale categorized tornadoes by intensity and area and was divided into six categories, F0 (gale) to F5 (incredible). Table 5.4.8-4 explains each of the six F-Scale categories.

Table 5.4.8-4. 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. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving cars blown off roads.

Scale	Wind Estimate (MPH)	Typical Damage
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 occur.

Source: SPC 2012

The Enhanced Fujita Scale (EF-Scale) is now the standard used to measure the strength of a tornado. 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 (DI) and Degree 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 considers how most structures are designed (NOAA 2008). Table 5.4.8-5 lists the EF-Scale and each of its six categories.

Table 5.4.8-5. 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 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 meters (109 yards); high-rise buildings have significant structural deformation; incredible phenomena occur.

Source: SPC date unknown

Tornado watches and warning are issued by the local NWS office. A tornado watch is released when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. The

current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2013; FEMA 2013).

Hurricanes and Tropical Storms

The extent of a hurricane is categorized in accordance with the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind 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 preventative measures (NOAA 2013). Table 5.4.8-6 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Table 5.4.8-6. The Saffir-Simpson Hurricane Scale

Category	Wind Speed (mph)	Storm Surge (feet)	Expected Damage
1	74-95 mph	3 to 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	6 to 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.
3 (major)	111-129 mph	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 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; NASA 2003
mph Miles per hour
> Greater than

Location

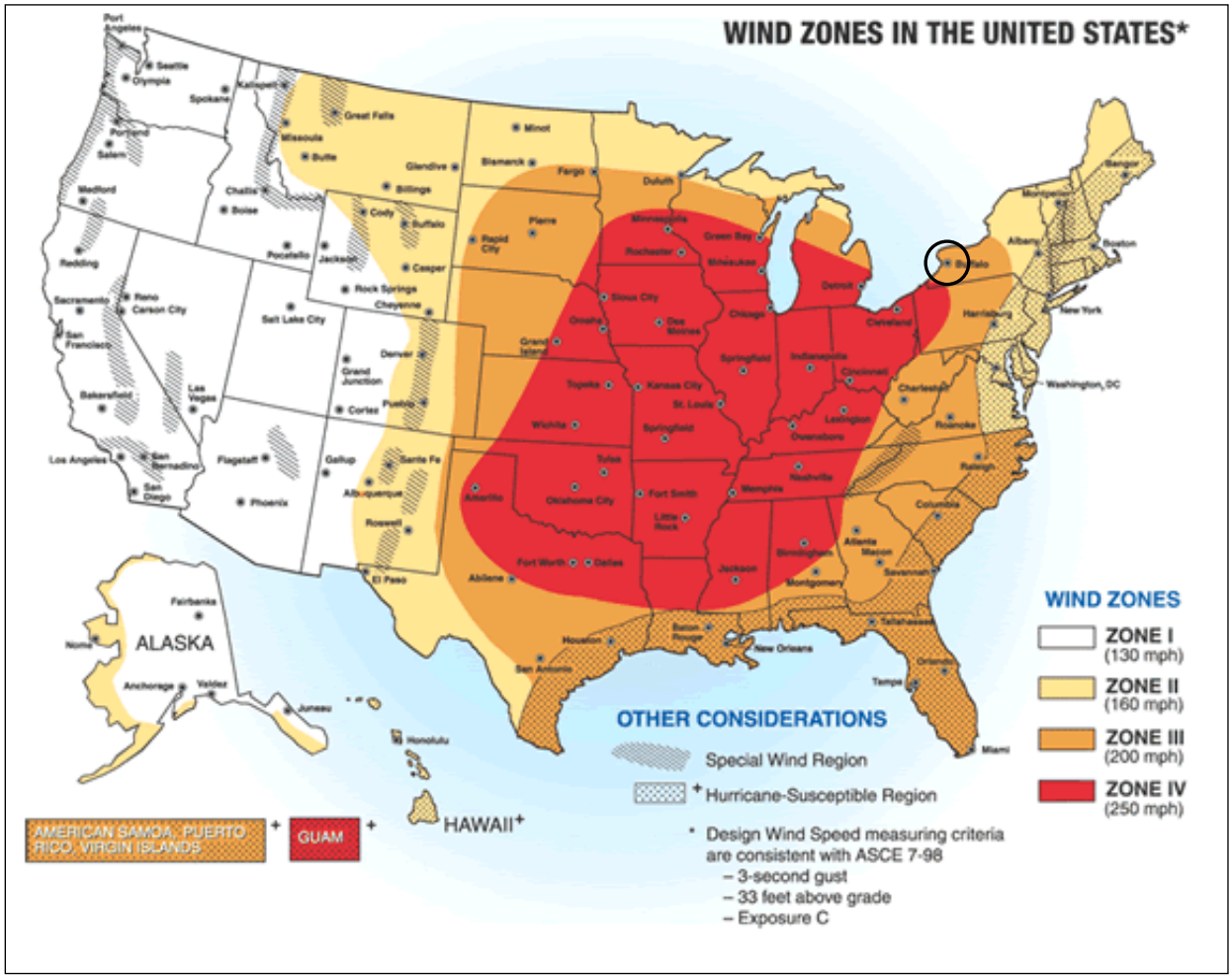
Hail

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, and thereby 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, thunderstorm, or lightning event.

Windstorms and High Winds

All of Genesee 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, Genesee County is located in Wind Zone III, where wind speeds can reach up to 200 mph. Figure 5.4.8-1 illustrates how the frequency and strength of windstorms impacts the United States, and the general location of the most wind activity. This is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA.

Figure 5.4.8-1. Wind Zones in the United States



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

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 the State of New York has a moderate frequency of lightning strikes, 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.

Thunderstorms

Thunderstorms affect relatively small localized areas, rather than large regions such as winter storms and hurricanes (NWS 2010). Thunderstorms can strike in all regions of the United States; however, they are common in the central and southern states. The atmospheric conditions in these regions of the country are most ideal for generating these powerful storms (Northern Virginia Regional Commission [NVRC] 2006). It is estimated that as many as 40,000 thunderstorms 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, Genesee 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 most. 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 definite 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 (NOAA 2013). Genesee County has experienced two tornadoes between 1950 and 2016 (SPC 2017).

Hurricanes and Tropical Storms

Hurricanes and tropical storms can impact New York State from June to November, the official eastern United States 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 (NYS DHSES 2014).

NOAA's 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 catalogs tropical cyclones that have occurred from 1842 to 2016 (latest date available from data source). Between 1950 and 2016, no tropical cyclones have been tracked within 65 nautical miles of Genesee County.

Genesee County is not frequently impacted by hurricanes, tropical storms, or tropical depressions. It 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. In 2012, Superstorm Sandy brought strong winds and heavy rains to Genesee County, which downed trees and power lines (NCDC 2017).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with hurricane events throughout New York State and Genesee 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 2017, FEMA declared that New York State experienced 55 severe storm-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe storm, heavy rain, high wind, hurricane/tropical storm, and tornado. Generally, these disasters cover a wide region 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 indicated that Genesee County has been included in seven declarations for severe storm-related events (FEMA 2017).

The U.S. Department of Agriculture (USDA) crop loss information provides 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 Genesee County has experienced crop losses from severe storm events. Details are provided in the Table 5.4.8-7.

Table 5.4.8-7. USDA Crop Losses from Severe Storms in Genesee County, 2012-2016

Year	Crop Type	Cause of Loss	Acres Damaged	Losses
2012	Wheat	Excess Moisture/Precip/Rain	634.1	$35,605
2012	Wheat	Excess Moisture/Precip/Rain	201.3	$17,931
2012	Onions	Hail	42.8	$54,519
2012	Corn	Excess Moisture/Precip/Rain	28.1	$1,276
2012	Soybeans	Excess Moisture/Precip/Rain	29.9	$1,126
2013	Wheat	Excess Moisture/Precip/Rain	0.7	$162
2013	Wheat	Excess Moisture/Precip/Rain	213.2	$57,372
2013	Onions	Excess Moisture/Precip/Rain	191.9	$164,531
2013	Forage Seeding	Excess Moisture/Precip/Rain	12.2	$3,355
2013	Corn	Excess Moisture/Precip/Rain	60	$2,712
2013	Corn	Excess Moisture/Precip/Rain	1254.2	$285,700
2013	Corn	Excess Moisture/Precip/Rain	58.9	$6,041
2013	Corn	Excess Moisture/Precip/Rain	537.6	$72,994
2013	Corn	Excess Moisture/Precip/Rain	123.9	$40,704
2013	Corn	Excess Moisture/Precip/Rain	25.1	$5,814
2013	Corn	Excess Moisture/Precip/Rain	1166.1	$254,230
2013	Corn	Excess Moisture/Precip/Rain	24.3	$7,977
2013	Corn	Excess Moisture/Precip/Rain	858.15	$325,727
2013	Sweet Corn	Excess Moisture/Precip/Rain	51	$9,016
2013	Sweet Corn	Excess Moisture/Precip/Rain	52	$3,125
2013	Processing Beans	Excess Moisture/Precip/Rain	26.4	$9,845
2013	Processing Beans	Wind/Excess Wind	130.3	$19,112
2013	Dry Beans	Excess Moisture/Precip/Rain	61.1	$10,149
2013	Dry Beans	Excess Moisture/Precip/Rain	66.7	$12,592
2013	Green Peas	Excess Moisture/Precip/Rain	156.1	$151,771
2013	Green Peas	Excess Moisture/Precip/Rain	2338.5	$800,605
2013	Green Peas	Excess Moisture/Precip/Rain	10.6	$10,108
2013	Soybeans	Excess Moisture/Precip/Rain	121.9	$13,303
2013	Soybeans	Excess Moisture/Precip/Rain	1319.1	$377,816
2013	Soybeans	Excess Moisture/Precip/Rain	376.2	$34,202
2013	Soybeans	Excess Moisture/Precip/Rain	88.13	$10,856
2013	Soybeans	Excess Moisture/Precip/Rain	10.9	$3,072
2013	Soybeans	Excess Moisture/Precip/Rain	515.4	$48,977

Year	Crop Type	Cause of Loss	Acres Damaged	Losses
2013	Soybeans	Excess Moisture/Precip/Rain	276.6	$45,966
2013	Soybeans	Excess Moisture/Precip/Rain	12	$463
2013	Soybeans	Other (Snow-Lightning-Etc.)	199.5	-$2,485
2013	Soybeans	Other (Snow-Lightning-Etc.)	30.5	$7,203
2013	Potatoes	Excess Moisture/Precip/Rain	26.5	$33,755
2013	Potatoes	Excess Moisture/Precip/Rain	56.15	$19,391
2013	Potatoes	Excess Moisture/Precip/Rain	19.5	-$9,953
2013	Barley	Excess Moisture/Precip/Rain	65.2	$8,999
2014	Wheat	Excess Moisture/Precip/Rain	11.4	$1,977
2014	Wheat	Excess Moisture/Precip/Rain	217.05	$31,375
2014	Corn	Excess Moisture/Precip/Rain	19.1	$3,618
2014	Corn	Excess Moisture/Precip/Rain	87.5	$11,175
2014	Corn	Excess Moisture/Precip/Rain	39.8	$8,769
2014	Corn	Excess Moisture/Precip/Rain	16.962	$3,295
2014	Corn	Excess Moisture/Precip/Rain	871.6	$285,260
2014	Corn	Excess Moisture/Precip/Rain	125.184	$58,714
2014	Corn	Other (Snow-Lightning-Etc.)	659.68	$66,581
2014	Corn	Other (Snow-Lightning-Etc.)	979.6	$28,120
2014	Sweet Corn	Excess Moisture/Precip/Rain	23	$3,140
2014	Sweet Corn	Excess Moisture/Precip/Rain	99	$6,018
2014	Processing Beans	Excess Moisture/Precip/Rain	341.2	$63,240
2014	Processing Beans	Excess Moisture/Precip/Rain	59	$32,856
2014	Processing Beans	Excess Moisture/Precip/Rain	402.9	$100,080
2014	Green Peas	Excess Moisture/Precip/Rain	39	$12,923
2014	Green Peas	Excess Moisture/Precip/Rain	167.4	-$8,028
2014	Green Peas	Excess Moisture/Precip/Rain	71	$39,791
2014	Green Peas	Excess Moisture/Precip/Rain	39	$43,704
2014	Soybeans	Excess Moisture/Precip/Rain	49.4	$6,576
2014	Soybeans	Excess Moisture/Precip/Rain	334	$86,727
2014	Soybeans	Excess Moisture/Precip/Rain	32	$5,744
2014	Soybeans	Excess Moisture/Precip/Rain	30.8	$7,426
2014	Potatoes	Excess Moisture/Precip/Rain	53.25	$18,915
2014	Barley	Excess Moisture/Precip/Rain	39.3	$3,832
2015	Wheat	Excess Moisture/Precip/Rain	74.6	$6,895
2015	Onions	Excess Moisture/Precip/Rain	36.1	$70,983
2015	Oats	Excess Moisture/Precip/Rain	15.6	$180
2015	Corn	Excess Moisture/Precip/Rain	27	$0
2015	Corn	Excess Moisture/Precip/Rain	41.7	$1,384
2015	Corn	Excess Moisture/Precip/Rain	240.2	$10,076
2015	Corn	Excess Moisture/Precip/Rain	63.6	$6,817
2015	Corn	Excess Moisture/Precip/Rain	533.4	$193,178
2015	Corn	Excess Moisture/Precip/Rain	92.75	$23,060

Year	Crop Type	Cause of Loss	Acres Damaged	Losses
2015	Corn	Excess Moisture/Precip/Rain	1115.7	$101,991
2015	Sweet Corn	Excess Moisture/Precip/Rain	38	$5,384
2015	Processing Beans	Excess Moisture/Precip/Rain	58	$34,500
2015	Processing Beans	Excess Moisture/Precip/Rain	201	$35,950
2015	Processing Beans	Excess Moisture/Precip/Rain	66.2	$17,850
2015	Dry Beans	Excess Moisture/Precip/Rain	27.8	$4,221
2015	Dry Beans	Excess Moisture/Precip/Rain	56.9	$10,887
2015	Dry Beans	Excess Moisture/Precip/Rain	70.3	$2,655
2015	Dry Beans	Excess Moisture/Precip/Rain	58.7	$4,601
2015	Green Peas	Excess Moisture/Precip/Rain	200.7	$135,442
2015	Green Peas	Excess Moisture/Precip/Rain	1839.7	$401,588
2015	Soybeans	Excess Moisture/Precip/Rain	11.2	$1,144
2015	Soybeans	Excess Moisture/Precip/Rain	852.55	$186,190
2015	Soybeans	Excess Moisture/Precip/Rain	386.9	$40,178
2016	Wheat	Excess Moisture/Precip/Rain	107.3	$7,327

Source: USDA 2017
Precip Precipitation

For this 2019 HMP Update, known severe storm events that have impacted Genesee County between 2007 and 2017 are identified in Table 5.4.8-8. The jurisdictional annexes included in Section 9 of the HMP provide detailed information on damages and impacts to each municipality. Please note that not all events that have occurred in Genesee County are included due to the extent of documentation and the fact that not all sources have been identified or researched. Loss and impact information 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 plan.

Table 5.4.8-8. Severe Storm Events in Genesee County, 2007 to 2017

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
June 8, 2007	Thunderstorm Wind	N/A	N/A	Afternoon and evening thunderstorms developed over western New York State. Strong winds from the storms downed trees and power lines throughout numerous municipalities in the area. Utility companies reported power outages throughout the area with upwards of 20,000 customers without power. In Genesee County, the Towns of LeRoy and Byron experienced downed trees and power lines. Overall, the County had approximately $20,000 in property damage from this event.
June 19, 2007	Severe Storms and Flooding	DR-1710	No	Strong, damaging thunderstorms produced large hail and strong winds that downed trees and power lines throughout the region. Power companies reported upwards of 20,000 customers without power. In Genesee County, damage was reported in the Towns of Byron and Oakfield. Overall, the County had approximately $20,000 in property damage from this event.
August 16, 2007	Thunderstorm Wind	N/A	N/A	Thunderstorms in the area produced damaging winds of up to 60 mph that downed trees and power lines. Several thousand were left without power due to the storm. In Genesee County, damage was reported at the Genesee County Airport in the City of Batavia. Overall, the County had approximately $15,000 in property damage from this event.
September 11, 2007	Thunderstorm Wind	N/A	N/A	Strong thunderstorms produced strong winds that downed trees and power lines. Overall, Genesee County had approximately $15,000 in property damage from this event.
January 9, 2008	High Wind	N/A	N/A	A powerful cold front crossed the region, bringing strong thunderstorms. The storms produced damaging winds that measured up to 75 mph. Trees and power lines were downed by the winds throughout the region. Many schools were closed due to the winds. Overall, Genesee County had approximately $175,000 in property damage from this event.
January 30, 2008	High Wind	N/A	N/A	Very strong west to southwest winds followed a powerful cold front that crossed western New York State. Sustained winds increased to 30 to 45 mph with gusts measuring at 80 mph at the peak of the storm. The winds downed trees and power lines throughout the region. Utility companies reported closed to 100,000 customers without power in locations scattered throughout the region. Several homes and cars were damaged by falling trees and limbs. Overall, Genesee County had approximately $150,000 in property damage from this event.
June 16, 2008	Hail	N/A	N/A	Western and central New Yorkers experienced a rare widespread large and damaging hail event on June 16th. Strong thunderstorms developed over the region produced large hail of up to two inches in diameter. The large hail damaged homes, windows and cars. The hail also damaged area crops (fruits and vegetables). USDA issued a disaster declaration for Erie, Genesee, Monroe, Ontario, Orleans, and Wayne counties. Overall, Genesee County had approximately $180,000 in property damage and $3.4 million in crop damage from this event.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
July 23, 2008	Hail	N/A	N/A	Thunderstorms developed across the area, producing damaging winds of up to 60 mph and hail measuring up to one inch in diameter. Scattered power outages were reported. The storms also dropped several inches of rain in a short amount of time. Overall, Genesee County had approximately $12,000 in property damage from this event.
July 27, 2008	Thunderstorm Wind	N/A	N/A	Severe thunderstorms moved across the area, producing strong winds of up to 60 mph. The winds downed trees and power lines, which led to scattered power outages in northern Erie and western Genesee Counties. Overall, Genesee County had approximately $10,000 in property damage from this event.
August 18, 2008	Thunderstorm Wind	N/A	N/A	Thunderstorms produced damaging winds, estimated near 60 mph, which downed trees and power lines in parts of Genesee and Jefferson Counties. Overall, Genesee County had approximately $20,000 in property damage from this event.
September 14, 2008	High Wind and Thunderstorms (remnants of Hurricane Ike)	N/A	N/A	Remnants of Hurricane Ike reached the lower Great Lakes region and brought high winds to the area. Wind gusts of up to 66 mph were measured. The winds downed trees and power lines throughout the area. Debris blocked many streets and highways. There were numerous reports of homes, buildings, and cars being damaged by fallen trees. In Genesee County, wind gusts of 59 mph were measured in the Village of Attica and 55 mph in the Town of Pembroke. Overall, Genesee County had approximately $115,000 in property damage from this event.
December 24-25, 2008	Thunderstorms and High Wind	N/A	N/A	High winds impacted much of western New York State, which were enhanced by the funneling effects of Lakes Erie and Ontario. The strong winds developed during the evening of December 24th and continued until early morning on December 25th. Overall, Genesee County had approximately $25,000 in property damage from this event
December 28, 2008	High Winds	N/A	N/A	Winds speeds of 30 to 40 mph were reported downwind of Lakes Erie and Ontario. Nearly 100,000 customers were without power during the storm and nearly 90,000 were without phone service. Downed trees damaged several structures and cars. The strong winds also tore off roofs and shingles on many buildings. Overall, Genesee County had approximately $100,000 in property damage from this event.
February 12, 2009	High Winds	N/A	N/A	Strong winds developed after a deep low pressure moved across southern Ontario and Lake Ontario to the New England coast. The winds impacted much of western New York State, with gusts measuring up to 69 mph. The strong winds downed trees and power lines, cutting power to nearly 100,000 customers. In Genesee County, 58 mph winds were reported in the Town of LeRoy. Overall, the County had approximately $30,000 in property damage from this event.
July 25, 2009	Tornado (EF1)	N/A	N/A	A tornado crossed the Town of Darien and Village of Corfu in Genesee County. The initial touchdown occurred on Reynolds Road in the Town of Darien. It then moved northeast across Routes 77 and 33 before lifting near Boyce Road. Widespread damage occurred in the Village of Corfu. Over 30 homes were damaged and three buildings were destroyed. Two greenhouses were also destroyed. Telephone poles were snapped and numerous trees were uprooted. Overall, the County had approximately $2 million in property damage from this event.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
August 8, 2009	Severe Storms and Flooding	DR-1857	No	Strong thunderstorms, heavy rain and high winds moved across western New York State. The storms resulted in widespread damage, downed trees, and flooding. Trees as large as two to three feet in diameter were downed by the winds. Power outages were scattered throughout the region. Heavy rains fell at a rate of 4 to 6 inches in less than 2 hours, which resulted in some of the worst flash flooding the area has experienced. FEMA declared the Counties of Erie, Chautauqua, Cattaraugus, and Allegany major disaster areas. In Genesee County, the strong winds downed trees and wires throughout the area. Overall, the County had approximately $20,000 in property damage from this event.
May 8, 2010	High Wind	N/A	N/A	Wind gusts of 60 to 65 mph were measured across the area. Tens of thousands of customers were without power. Overall, the County had approximately $100,000 in property damage from this event.
July 21, 2010	Thunderstorms and Wind	N/A	N/A	Thunderstorms produced large hail and damaging winds. Hail up to 1.75 inches in diameter was reported in Ontario, Wayne, and Jefferson Counties. The thunderstorm winds downed trees and power lines in Lyons, Rochester, Brighton, Clayton, Cape Vincent, Elba (Genesee County), Adams Center, Fulton and Constableville. Utility companies reported thousands without power. In Genesee County, a large tree was reported down in the Town of Elba. Overall, the County had approximately $10,000 in property damage from this event.
August 16, 2010	Thunderstorms and Wind	N/A	N/A	Thunderstorms produced strong winds that downed trees and power lines in the area. In Genesee County, trees were down in Indian Falls (Town of Pembroke). Overall, the County had approximately $10,000 in property damage from this event.
September 7, 2010	Thunderstorms and Wind	N/A	N/A	A strong thunderstorm produced wind gusts of up to 60 mph. The winds downed trees and power lines in the Towns of Alabama, Pembroke, and Darien in Genesee County. Overall, the County had approximately $24,000 in property damage from this event.
April 28, 2011	Severe Storms, Flooding, Tornadoes, and Straight-Line Winds	DR-1993	No	Strong winds, with gusts of up to 83 mph, developed across western New York State, downing trees and power lines. In Genesee County, a tractor trailer was overturned in the Town of Alabama. Overall, the County had approximately $30,000 in property damage from this event.
August 25, 2011	Hurricane Irene	EM-3328 DR-4020	No	Thunderstorms developed during the evening of August 25th. Wind gusts measured up to 60 mph, downing trees and power lines. In Genesee County, a home was damaged when a lightning strike caused a fire in East Pembroke. Overall, the County had approximately $25,000 in property damage from this event.
January 17, 2012	Thunderstorms and Wind	N/A	N/A	Thunderstorms produced wind gusts of up to 70 mph across the region. The strong winds downed trees and power lines. Power outages were scattered throughout the region. In Genesee County, there were multiple reports of downed trees and power lines in the Towns of Darien, Pembroke, Oakfield, Byron, and LeRoy. Overall, the County had approximately $104,000 in property damage.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
July 7, 2012	Thunderstorms	N/A	N/A	An isolated thunderstorm produced damaging winds in the City of Batavia. Trees and limbs were downed and an automobile was crushed by a fallen tree. Overall, the County had approximately $20,000 in property damage from this event.
September 6, 2012	Hail	N/A	N/A	Showers and thunderstorms moved over the region. Wind gusts from the storms downed trees and power lines. In Genesee County, several large tents were blown over in the Town of Alexander. Dime-sized hail fell in the Town as well. Overall, the County had approximately $10,000 in property damage from this event.
September 8, 2012	Thunderstorms	N/A	N/A	A line of thunderstorms produced strong winds that downed trees and power lines. Utility companies reported tens of thousands of customers without power. In Indian Falls, there were reports of downed trees and wires. Overall, the County had approximately $10,000 in property damage from this event.
October 29, 2012	Remnants of Hurricane Sandy	DR-4085	Yes	Remnants of Hurricane Sandy brought strong winds and heavy rains to western and north central New York State. Rainfall amounts of 2 to 5 inches were measured across the area with some area creeks reaching or overflowing their banks. The high winds downed trees and power lines throughout the region. Wind gusts were measured up to 60 mph. Tree damage was greater than usual with such wind speeds because of saturated ground and northeast winds. In Genesee County, there were reports of downed trees and power lines throughout. Overall, the County had approximately $150,000 in property damage from this event.
January 20, 2013	High Wind	N/A	N/A	Strong, damaging winds in the region downed trees, utility poles, and power lines. Numerous roads were blocked by fallen trees, wires, and debris. Structural damage was also reported. In Genesee County, there were reports of downed trees and wires in the Town of Pembroke. Overall, the County had approximately $15,000 in property damage from this event.
January 31, 2013	High Wind	N/A	N/A	Strong winds downed trees and power lines in the Town of Pembroke, causing approximately $10,000 in property damage.
May 22, 2013	Severe Storms and Flooding	N/A	N/A	Strong thunderstorms produced large hail and damaging winds. In the City of Batavia, there were reports of downed trees and wires. Overall, the County had approximately $10,000 in property damage from this event.
July 19, 2013	Thunderstorms and Wind	N/A	N/A	Thunderstorms moved across the region with wind gusts of up 60 mph. The strong winds downed trees and power lines. Scattered power outages were reported. Many roads were blocked by fallen trees and debris. There were several reports of minor structural damage as well. In Genesee County, there were reports of downed trees in the Town of Darien. Overall, the County had approximately $10,000 in property damage from this event.
June 17, 2014	Thunderstorms and Wind	N/A	N/A	A series of thunderstorms produced strong, damaging winds and hail. There were numerous reports of downed trees and power lines and structural damage due to the wind and hail. In Genesee County, there were reports of downed trees and wires throughout the County. Overall, the County had approximately $25,000 in property damage from this event.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
July 8, 2014	Thunderstorms and Wind	N/A	N/A	Thunderstorms produced strong winds and caused widespread damage throughout the region. The highest wind gust was measured at 66 mph. In Genesee County, trees were reported down along Route 20 in Pavilion. Overall, the County had approximately $10,000 in property damage from this event.
December 24-25, 2014	Thunderstorms and High Wind	N/A	N/A	Strong winds gusted to 67 mph, downed trees and power lines throughout the region. Tractor trailers were overturned, roofs were torn off buildings, and utility poles were knocked down. Genesee County experienced downed trees and power lines from this event. Overall, the County had approximately $55,000 in property damage from this event.
January 4, 2015	High Wind	N/A	N/A	Overall, Genesee County had approximately $20,000 in property damage from this event.
April 10, 2015	High Wind	N/A	N/A	Strong, damaging winds developed across parts of western New York State, mainly downwind of Lakes Erie and Ontario. Wind gusts ranged from 58 mph to 62 mph. In Genesee County, the strong winds tore off large roof vents of buildings in the City of Batavia and snapped utility poles. Thousands of people were without power. Overall, the County had approximately $35,000 in property damage from this event.
April 20, 2015	Thunderstorm Wind	N/A	N/A	In East Pembroke, an isolated thunderstorm produced strong winds that brought down several trees near the intersection of Indian Falls and Pratt Roads. Overall, Genesee County had approximately $10,000 in property damage from this event.
May 11, 2015	Thunderstorm Wind	N/A	N/A	A line of thunderstorms moved across the Niagara Frontier, producing strong winds with gusts of up to 60 mph. Trees and power lines were downed from the winds in the Towns of Fargo and Pembroke in Genesee County. In Darien, there were reports of downed trees and wires. In Pembroke, there were trees and wires down on Maple Road. Overall, Genesee County had approximately $35,000 in property damage from this event.
June 23, 2015	Thunderstorm Wind	N/A	N/A	A series of showers and thunderstorms moved across the lower Great Lakes Region, bringing strong winds that downed trees, power lines and damaged structures and cars. Some roadways were closed due to debris. In Genesee County, there were multiple reports of downed trees and power lines in Batavia, Bethany Center, Stafford, LeRoy, and Pavilion Center. Overall, the County had approximately $65,000 in property damage from this event.
June 2, 2016	Lightning	N/A	N/A	Thunderstorms moved across the region from west to east as a cold front approached. In Genesee County, a lighting strike from one of the storms started a house fire on Shepard Road in the Town of Pavilion. Overall, Genesee County had approximately $20,000 in property damage from this event.
July 14, 2016	Thunderstorms and Lightning	N/A	N/A	Thunderstorms moved across southern Ontario and the eastern Great Lakes crossing western New York. The thunderstorms produced wind gusts that measured up to 62 mph. A majority of the damage from these storms were downed trees and power lines. In Genesee County, there were downed trees on Tesnow Road in the Town of Alabama. In the Town of LeRoy, there were downed trees on West Main Street. In the City of Batavia,

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
				downed trees were reported on South River Street. Overall, Genesee County had approximately $45,000 in property damage from this event.
August 10, 2016	Lightning	N/A	N/A	In the Town of Batavia, two people died as a result of a lightning strike from a series of thunderstorms.
August 13, 2016	Thunderstorm Wind	N/A	N/A	Thunderstorms developed across western New York State, bringing strong winds that downed trees and power lines in the region. In Genesee County, there were reports of downed trees in Bethany Center. Overall, Genesee County had approximately $8,000 in property damage from this event.
September 17, 2016	Thunderstorm Wind	N/A	N/A	A line of thunderstorms produced damaging winds and downed trees and power lines in Genesee County. There were reports of downed trees and power lines in the Village of Corfu. Overall, Genesee County had approximately $10,000 in property damage from this event.
January 4, 2017	High Wind	N/A	N/A	Deep cold air building across the region brought strong, gusty winds to the eastern end of Lake Erie. Wind gusts measured between 50 and 60 mph across parts of Erie, Genesee and Chautauqua Counties. Power outages were reported throughout the region. In Genesee County, the strong winds blew down a portion of a concrete block building wall in East Pembroke. Downed trees and power lines were also reported throughout the County. Overall, Genesee County had approximately $50,000 in property damage from this event.
January 11, 2017	High Wind	N/A	N/A	Gusty winds accompanied the passage of a deepening storm system crossing the upper Great Lakes. Wind gusts of 64 mph were measured at Dunkirk, Batavia (Genesee County) and Niagara Falls Airport. The strong winds downed trees and power lines. Several thousand customers were without power. Numerous roads were closed due to fallen trees. In Genesee County, strong winds downed trees and power lines. Overall, Genesee County had approximately $75,000 in property damage from this event.
March 1, 2017	High Wind	N/A	N/A	Strong winds downed trees and power lines throughout the region. Gusts as high as 64 mph were measured. In Genesee County, a gas station canopy was knocked over in the City of Batavia where wind gusts of 61 mph were recorded. Overall, Genesee County had approximately $25,000 in property damage from this event.
March 8, 2017	High Wind	N/A	N/A	Strong winds impacted the entire region, with sustained winds of up to 49 mph and wind gusts as high as 81 mph. Areas that were hit hard included parts of Orleans, Monroe, and Genesee Counties. In Genesee County, the strong winds derailed a train in the City of Batavia. Twelve out of 31 freight cars were blown off the tracks. Wind gusts of 76 mph were reported in Batavia. Several buildings were damaged due to wind in the City as well. A driver was injured when a tractor trailer overturned due to the wind in the Town of Alexander. Overall, Genesee County had approximately $500,000 in property damage from this event.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
April 4, 2017	Thunderstorm Wind	N/A	N/A	Wind gusts of up to 59 mph were measured in the area, downing trees and power lines throughout the region. Overall, Genesee County had approximately $30,000 in property damage from this event.
May 1, 2017	Thunderstorm Wind	N/A	N/A	A line of thunderstorms produced damaging winds that downed trees and wires across western New York State. Some of the downed trees caused minor structural damage. Wind gusts measured 60 mph. The line of storms also produced heavy rainfall, with amounts of 0.75 to 1.5 inches over a few hours. There were road closures due to flooding, mainly in flood-prone areas of communities. In Genesee County, there were downed trees reported in the Towns of Alabama, Alexander, Pavilion, and Oakfield. Overall, Genesee County had approximately $45,000 in property damage from this event.

Sources: *NOAA-NCEI 2017; FEMA 2017; NWS 2017*
DR *Major Disaster Declaration*
EM *Emergency Declaration*
FEMA *Federal Emergency Management Agency*
mph *Miles per hour (wind)*
N/A *Not applicable*
NOAA *National Oceanic and Atmospheric Administration*
NCEI *National Centers for Environmental Information*
NWS *National Weather Service*

Probability of Future Events

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).

Table 5.4.8-9 provides the probability of occurrences of severe storm events. Based on historic occurrences, thunderstorm events are the most common in Genesee County, followed by hail events. However, the information used to calculate the probability of occurrences is only based on using NOAA-NCEI storm event database results.

Table 5.4.8-9. Probability of Occurrence of Severe Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2016	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Hail	26	0.39	2.58	0.39	38.8
Hurricane / Tropical Storm	0	0	0	0	0
Lightning	0.05	22.33	0.04	4.48	0.05
Strong / High Winds	40	0.61	1.68	0.60	59.7
Thunderstorms	114	1.73	0.59	1	100
Tornado	2	0.03	33.50	0.03	3

Source: *NOAA-NCEI 2017*
Note: *Probability was calculated using the available data provided in the NOAA-NCEI storm events database.*

It is estimated that Genesee County will continue to experience 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.

In Section 5.3, the identified hazards of concern for Genesee 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 Committee, 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 5.3-1).

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. The Integrated Assessment for Effective Climate Change in New York State (ClimAID) was tasked 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. Genesee County is part of Region 1, Western New York, Great Lakes Plain (shown on Figure 5.4.8-2). Some of the issues in this region affected by climate change include the fact that this region has the highest agricultural revenue in the State; relatively low rainfall, and therefore, increased summer drought risk; irrigation for high-value crops; improved condition for grapes (NYSERDA 2011).

Figure 5.4.8-2. Climate Regions of New York State

Source: NYSERDA 2011

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

Annual average precipitation is projected to increase by up to 1 to 8 percent by the 2020s, by 3 to 12 percent by the 2050s, and 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 State of New York are expected to see the greatest increases in precipitation (NYSERDA 2014).

The projected increase in precipitation is expected to occur by 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, with 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. There has also been an increase in the number of 2-inch rainfall events over a 48-hour period 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).

5.4.8.2 Vulnerability Assessment

To understand risk, a community must evaluate exposed or vulnerable assets in the identified hazard area. For severe storms, the entire County is considered vulnerable. Therefore, all assets (population, structures, critical facilities, and lifelines), as described in Section 4, are vulnerable. This section evaluates and estimates potential impacts of the drought hazard on the County, including:

- 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
- Change of vulnerability as compared to that presented in the 2008 Genesee County Hazard Mitigation Plan
- Effect of climate change on vulnerability
- 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.

Due to the large geographic area that covers both coastal and inland locations, the loss associated with hurricanes can vary (see flooding discussion in Section 5.4.6, Flood). Secondary flooding associated with torrential downpours during hurricanes and tropical storms is also a concern in Genesee County.

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 due to 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.

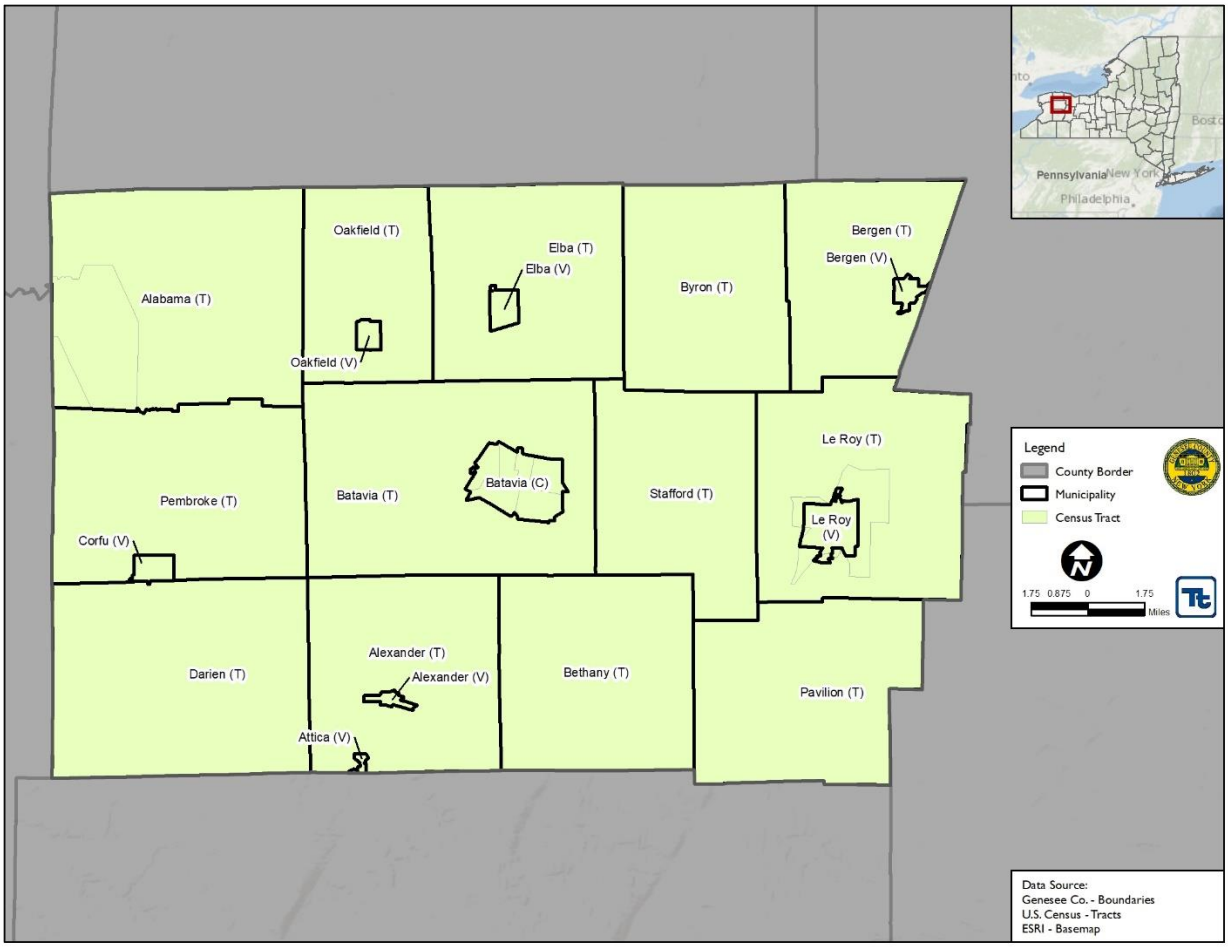
Data and Methodology

After reviewing historic data, the HAZUS-MH methodology and wind model were used to analyze the severe storm hazard for Genesee County. Information used to assess this hazard include data available in the HAZUS-MH hurricane model, professional knowledge, information provided by the Steering Committee, and input from the public.

A probabilistic scenario was run for Genesee County for the 100- and 500-year MRPs to estimate potential impacts from the severe storm hazard. Based on the HAZUS-MH model, the maximum peak gust wind speeds for both the 100-year MRP and 500-year wind events were less than 39 mph and do not equate to at least a tropical storm. However, when examining the historical record, Genesee County has experienced higher wind gusts, high wind storms and tornados with greater wind speeds than estimated by the HAZUS-MH model. Therefore, the HAZUS-MH results are underestimating the potential loss to the County as a result of wind event.

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 events (severe wind impacts). Updated critical facility inventories and general building stock data were used in this evaluation. The model was run at the census-tract level for the County. Figure 5.4.8-3 displays the relationship between the municipalities and census tracts.

Figure 5.4.8-3. HAZUS-MH Census Tracts in Genesee County



Source: U.S. Census

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 is provided to residents. It is assumed that the entire County's population (U.S. Census 2010 population of 60,079 people) is exposed to the severe storm hazard.

Unfortunately, some tornadoes strike with little or no warning and residents must act quickly. The following populations are more vulnerable to a tornado or other type of wind or severe storm event: 1) population located in communities without, or having ineffective, early warning systems; 2) population with functional needs and/or over the age of 65 because they may have more difficulty evacuating or seeking shelter; 3) economically disadvantaged populations 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; 4) population with a language barrier unable to follow warning messages; 5) population in mobile homes; and 5) population in automobiles at the time of a tornado. The elderly and functional needs populations are considered most vulnerable because they require extra time or outside assistance to seek shelter and are more likely to seek or need medical attention, which may not be available due to isolation during and/or after an event.

Tornadoes and strong wind events have been known to devastate entire cities and landscapes, often leaving people without food, water or shelter for days, weeks or even longer. If severe enough, wind and tornado events

can permanently displace people who will have to relocate to a new home or find temporary housing. 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. 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. However, HAZUS-MH's estimate is based on wind speeds of less than 39 mph and therefore may be underestimating the County's potential sheltering need as a result of a severe storm event.

Impact on General Building Stock

After considering the population exposed to the severe storm hazard, 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 model 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).

It is assumed that the entire County's general building stock is exposed to the severe storm wind hazard (greater than $7 billion structure only). Estimated building damage was evaluated by HAZUS across the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 5.4.8-10 summarizes the definitions of the damage categories.

Table 5.4.8-10. 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 of 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	< 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%	1 to 3 Panels	Typically 5 to 10 Impacts	No	No
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	> 3 and ≤ 25%	Typically 10 to 20 Impacts	No	No
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: FEMA date unknown

As noted earlier in the profile, HAZUS-MH estimates the 100-year and 500-year MRP peak gust wind speeds for Genesee County to be less than 39 mph. For the both events, HAZUS-MH estimates $0 in structure damage. However, as noted, HAZUS-MH may be underestimating the potential impacts to Genesee County as a result of a high wind event.

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.

Manufactured housing (i.e. mobiles homes) is particularly vulnerable to high winds. The U.S. Census Bureau defines manufactured homes as "movable dwellings, 8 feet or wider and 40 feet or longer, design to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (Census, 2010)." They can include multi-wides and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their light-weight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Table 5.4.8-11 displays the number of manufactured housing units per municipality in Genesee County.

Table 5.4.8-11. Manufactured Housing Units per Municipality in Genesee County

Municipality	Number of Manufactured Homes
Alabama (T)	112
Alexander (T)	33
Alexander (V)	14
Attica (V)	3
Batavia (C)	59
Batavia (T)	627
Bergen (T)	79
Bergen (V)	32
Bethany (T)	20
Byron (T)	161
Corfu (V)	10
Darien (T)	0
Elba (T)	51
Elba (V)	15
Le Roy (T)	69
Le Roy (V)	0
Oakfield (T)	43
Oakfield (V)	41
Pavilion (T)	131
Pembroke (T)	64
Stafford (T)	0
County Total	**1,564**

Source: HAZUS-MH v4.0

Impact on Critical Facilities

HAZUS-MH estimates the probability that critical facilities (i.e., medical facilities, fire/emergency medical services, police, emergency operations 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 Genesee 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-year or 500-year MRP events. As noted, HAZUS-MH may be underestimating the potential impacts to Genesee County critical facilities as a result of a high wind event.

At this time, HAZUS-MH 4.0 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, falling debris, etc. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term transportation needs (e.g., day-to-day commuting).

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 (including the young and elderly, who are particularly vulnerable to temperature-related health impacts).

Impact on Economy

Severe storms also impact the economy, including loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss, and rental loss due to the repair/replacement of buildings. 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 include losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their homes because of the event.

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

HAZUS-MH 4.0 also estimates the amount of debris that may be produced a result of the 100- and 500-year MRP wind events. HAZUS-MH 4.0 estimates that there will be no debris generated as a result of the 100- and 500-yr 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.

Future Growth and Development

As discussed and illustrated in Section 4, areas targeted for future growth and development have been identified across Genesee 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, Genesee 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 particular buildings or infrastructure age or year built 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 plan.