## 5.4.10 Severe Storm

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

### Hazard Profile

Hazard profile information is provided in this section, including information on description, extent, location, previous occurrences and losses and the probability of future occurrences within Suffolk County.

#### Description

For the purpose of this HMP and as deemed appropriated by Suffolk County, the severe storm hazard includes hailstorms, windstorms, lightning, thunderstorms, and tornadoes which are defined below. Since most northeasters, (or Nor'Easters) a type of an extra-tropical cyclone, generally take place during the winter weather months, Nor'Easters have been grouped as a type of severe winter weather storm, further discussed in Section 5.4.9 (Nor'Easters).

Hailstorm: According to the National Weather Service (NWS), hail is defined as a showery precipitation in the form of irregular pellets or balls of ice more than five millimeters in diameter, falling from a cumulonimbus cloud (NWS, 2009). Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight; they fall as precipitation, in the form of balls or irregularly shaped masses of ice. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size. Hailstorms are a potential damaging outgrowth of severe thunderstorms (Northern Virginia Regional Commission [NVRC], 2006). Hail causes nearly $2 billion in crop and property damages, on average, each year in the U.S. Hail occurs most frequency in the southern and central plain states; however, since hail occurs with thunderstorms, the possibility of hail damage exists throughout the entire U.S. (Federal Alliance for Safe Homes, 2006).

Windstorm: According to the Federal Emergency Management Agency (FEMA), wind is air moving from high to low pressure. It is rough horizontal movement of air (as opposed to an air current) caused by uneven heating of the Earth's surface. It occurs at all scales, from local breezes generated by heating of land surfaces and lasting tens of minutes to global winds resulting from solar heating of the Earth (FEMA, 1997). A type of windstorm that is experienced often during rapidly moving thunderstorms is a derecho. A derecho is a widespread and long-lived windstorm associated with thunderstorms that are often curved in shape (Johns et al., 2013). The two major influences on the atmospheric circulation are the differential heating between the equator and the poles, and the rotation of the planet. Windstorm events are associated with cyclonic storms (for example, hurricanes, thunderstorms and tornadoes (FEMA, 1997).

Lightning: According to the NWS, lightning is a visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds or between a rain cloud and the ground (NWS, 2009). The discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm creates a "bolt" when the buildup of charges becomes strong enough. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit (°F). Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder. Annually, on average, 300 people are injured and 89 people are killed due to lightning strikes in the U.S. (NVRC, 2006).

Thunderstorm: 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. These storms occur most commonly in the tropics. Many tropical land-based locations experience over 100 thunderstorm days each year (Pidwirny, 2007). Although thunderstorms generally affect a small area when they occur, they have the potential to become dangerous due to their ability in generating tornadoes, hailstorms, strong winds, flash flooding, and lightning. The NWS considers a thunderstorm severe only if it produces damaging wind gusts of 58 mph or higher or large hail one-inch (quarter size) in diameter or larger or tornadoes (NWS, 2010).

Tornado: A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. It is spawned by a thunderstorm (or sometimes as a result of a hurricane) and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. Tornado season is generally March through August, although tornadoes can occur at any time of year. Tornadoes tend to strike in the afternoons and evening, with over 80 percent (%) of all tornadoes striking between noon and midnight (New Jersey Office of Emergency Management [NJOEM], 2012). The average forward speed of a tornado is 30 mph, but can vary from nearly stationary to 70 mph (NWS, Date Unknown). The NOAA Storm Prediction Center (SPC) indicates that the total duration of a tornado can last between a few seconds to over one hour; however, a tornado typically lasts less than 10 minutes (Edwards, 2012). High-wind velocity and wind-blown debris, along with lightning or hail, result in the damage caused by tornadoes. Destruction caused by tornadoes depends on the size, intensity, and duration of the storm. Tornadoes cause the greatest damage to structures that are light, such as residential homes and mobile homes, and tend to remain localized during impact (NVRC, 2006).

## Extent

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

### Hail

Hail can be produced from many different types of storms. Typically, hail occurs with thunderstorm events. 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 (NYS DHSES, 2011). Table 5.4.10-1 shows the different types of hail and the comparison to real-world objects.

**Table 5.4.10-1. Hail Size**

| Description | Diameter (in inches) |
|---|---|
| Pea | 0.25 |
| Marble or mothball | 0.50 |
| Penny or dime | 0.75 |

| Description | Diameter (in inches) |
|---|---|
| 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 HMP, 2014*

## Tornado

The magnitude or severity of a tornado was originally categorized using the Fujita Scale (F-Scale) or Pearson Fujita Scale introduced in 1971, based on a relationship between the Beaufort Wind Scales (B-Scales) (measure of wind intensity) and the Mach number scale (measure of relative speed). It is used to rate the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure (Tornado Project, Date Unknown). The F-Scale categorizes each tornado by intensity and area. The scale is divided into six categories, F0 (Gale) to F5 (Incredible) (Edwards, 2012). Table 5.4.10-2 explains each of the six F-Scale categories.

### Table 5.4.10-2. Fujita Damage Scale

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

| Scale | Wind Estimate (MPH) | Typical Damage |
|---|---|---|
| F5 | 261-318 | Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur. |

*Source: SPC, 2012*

Although the F-Scale has been in use for over 40 years, there are limitations of the scale. The primary limitations are a lack of damage indicators, no account of construction quality and variability, and no definitive correlation between damage and wind speed. These limitations have led to the inconsistent rating of tornadoes and, in some cases, an overestimate of tornado wind speeds. The limitations listed above led to the development of the Enhanced Fujita Scale (EF Scale). The Texas Tech University Wind Science and Engineering (WISE) Center, along with a forum of nationally renowned meteorologists and wind engineers from across the country, developed the EF Scale (NWS, 2008).

The EF Scale became operational on February 1, 2007. It is used to assign tornadoes a 'rating' based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators (DIs) and 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 has to do with how most structures are designed (NWS, 2008). Table 5.4.10-3 displays the EF Scale and each of its six categories.

### Table 5.4.10-3. 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 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur. |

*Source: SPC, Date Unknown*

In the Fujita Scale, there was a lack of clearly defined and easily identifiable damage indicators. The EF Scale takes into account more variables than the original F-Scale did when assigning a wind speed rating to a tornado. The EF Scale incorporates 28 DIs, such as building type, structures, and trees. For each damage indicator, there are eight DODs, ranging from the beginning of visible damage to complete destruction of the damage indicator. Table 5.4.10-4 lists the 28 DIs. Each one of these indicators has a description of the typical construction for that category of indicator. Each DOD in every category is given an expected estimate of wind speed, a lower bound of wind speed, and an upper bound of wind speed.

**Table 5.4.10-4. EF Scale Damage Indicators**

| Number | Damage Indicator | Abbreviation | Number | Damage Indicator | Abbreviation |
|---|---|---|---|---|---|
| **1** | Small barns, farm outbuildings | SBO | **15** | School - 1-story elementary (interior or exterior halls) | ES |
| **2** | One- or two-family residences | FR12 | **16** | School - jr. or sr. high school | JHSH |
| **3** | Single-wide mobile home (MHSW) | MHSW | **17** | Low-rise (1-4 story) bldg. | LRB |
| **4** | Double-wide mobile home | MHDW | **18** | Mid-rise (5-20 story) bldg. | MRB |
| **5** | Apt, condo, townhouse (3 stories or less) | ACT | **19** | High-rise (over 20 stories) | HRB |
| **6** | Motel | M | **20** | Institutional bldg. (hospital, govt. or university) | IB |
| **7** | Masonry apt. or motel | MAM | **21** | Metal building system | MBS |
| **8** | Small retail bldg. (fast food) | SRB | **22** | Service station canopy | SSC |
| **9** | Small professional (doctor office, branch bank) | SPB | **23** | Warehouse (tilt-up walls or heavy timber) | WHB |
| **10** | Strip mall | SM | **24** | Transmission line tower | TLT |
| **11** | Large shopping mall | LSM | **25** | Free-standing tower | FST |
| **12** | Large, isolated ("big box") retail bldg. | LIRB | **26** | Free standing pole (light, flag, luminary) | FSP |
| **13** | Automobile showroom | ASR | **27** | Tree - hardwood | TH |
| **14** | Automotive service building | ASB | **28** | Tree - softwood | TS |

*Source: SPC, Date Unknown*

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

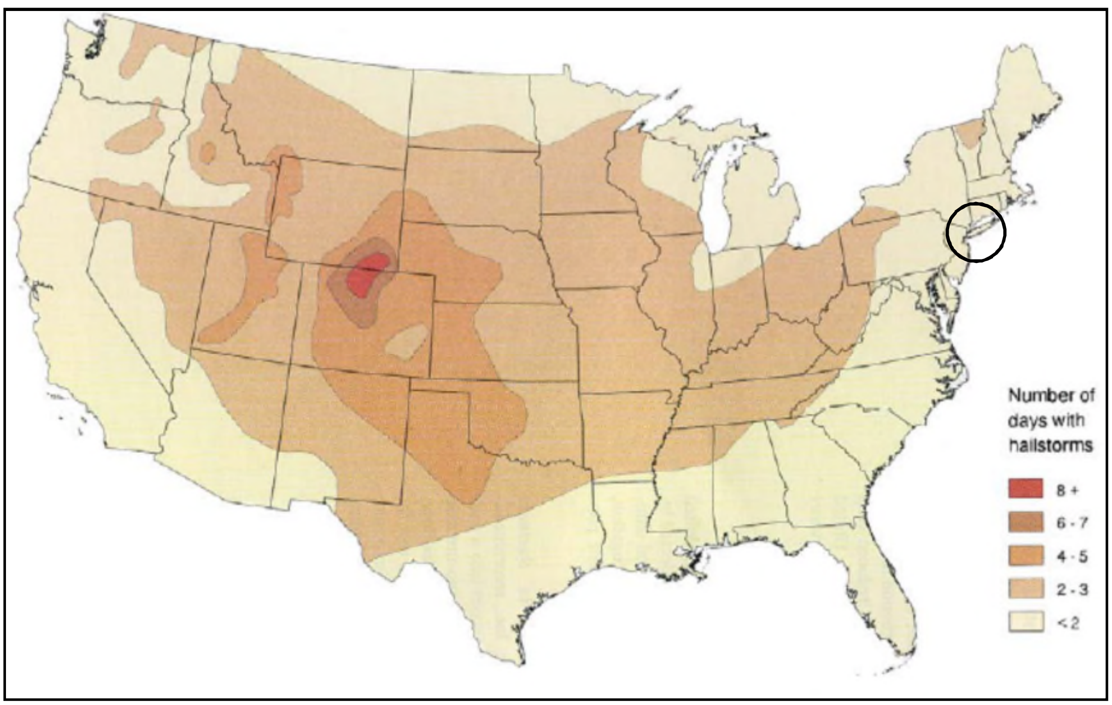
## Location

Severe storms are a common natural hazard in New York State because the State exhibits a unique blend of weather (geographically and meteorological) features that influence the potential for severe storms and associated flooding. Factors include temperature, which is affected by latitude, elevation, proximity to water bodies and source of air masses; and precipitation which includes snowfall and rainfall. Precipitation intensities and effects are influenced by temperature, proximity to water bodies, and general frequency of storm systems. The Cornell Climate Report also indicates that the geographic position of the State (Northeast U.S.) makes it vulnerable to frequent storm and precipitation events. This is because nearly all storms and frontal systems moving eastward across the continent pass through, or in close proximity to New York State. Additionally, the potential for prolonged thunderstorms or coastal storms and periods of heavy precipitation is increased throughout the state because of the available moisture that originates from the Atlantic Ocean (NYS DHSES, 2011).

### Hailstorms

Hailstorms are more frequent in the southern and central plain states, where the climate produces violent thunderstorms. However, hailstorms have been observed in almost every location where thunderstorms occur (Federal Alliance for Safe Homes, Inc., 2013). Figure 5.4.10-1 illustrates that Suffolk County and most of New York State experience less than two hailstorms per year.

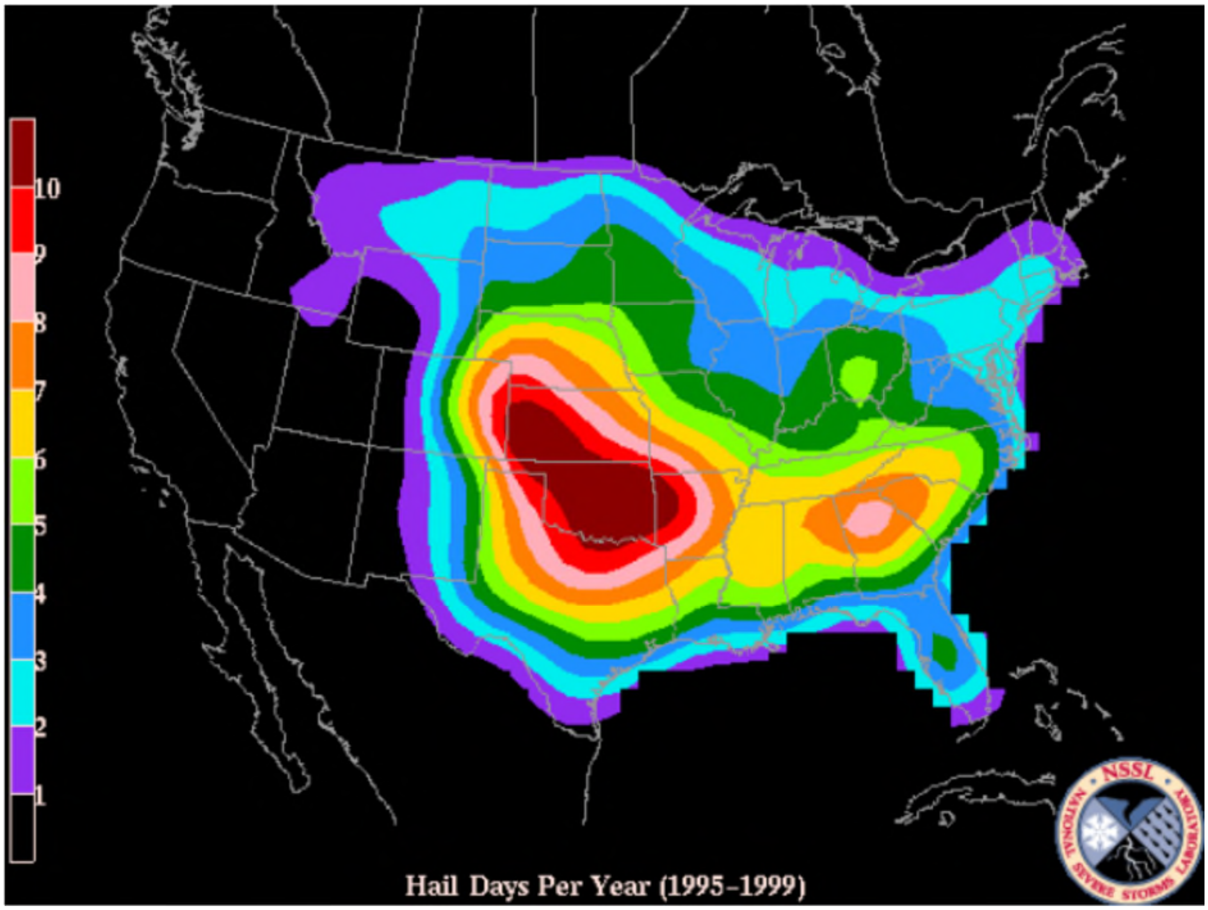
**Figure 5.4.10-1. Annual Frequency of Hailstorms in the U.S.**




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

Figure 5.4.10-2 illustrates the number of hail days, per year, between 1995 and 1999 in the U.S. According to this figure, New York State experiences between one and three days of hail each year. Suffolk County experiences hail between one and three days.

**Figure 5.4.10-2. Total Annual Threat of Hail Events in the U.S., 1995-1999**

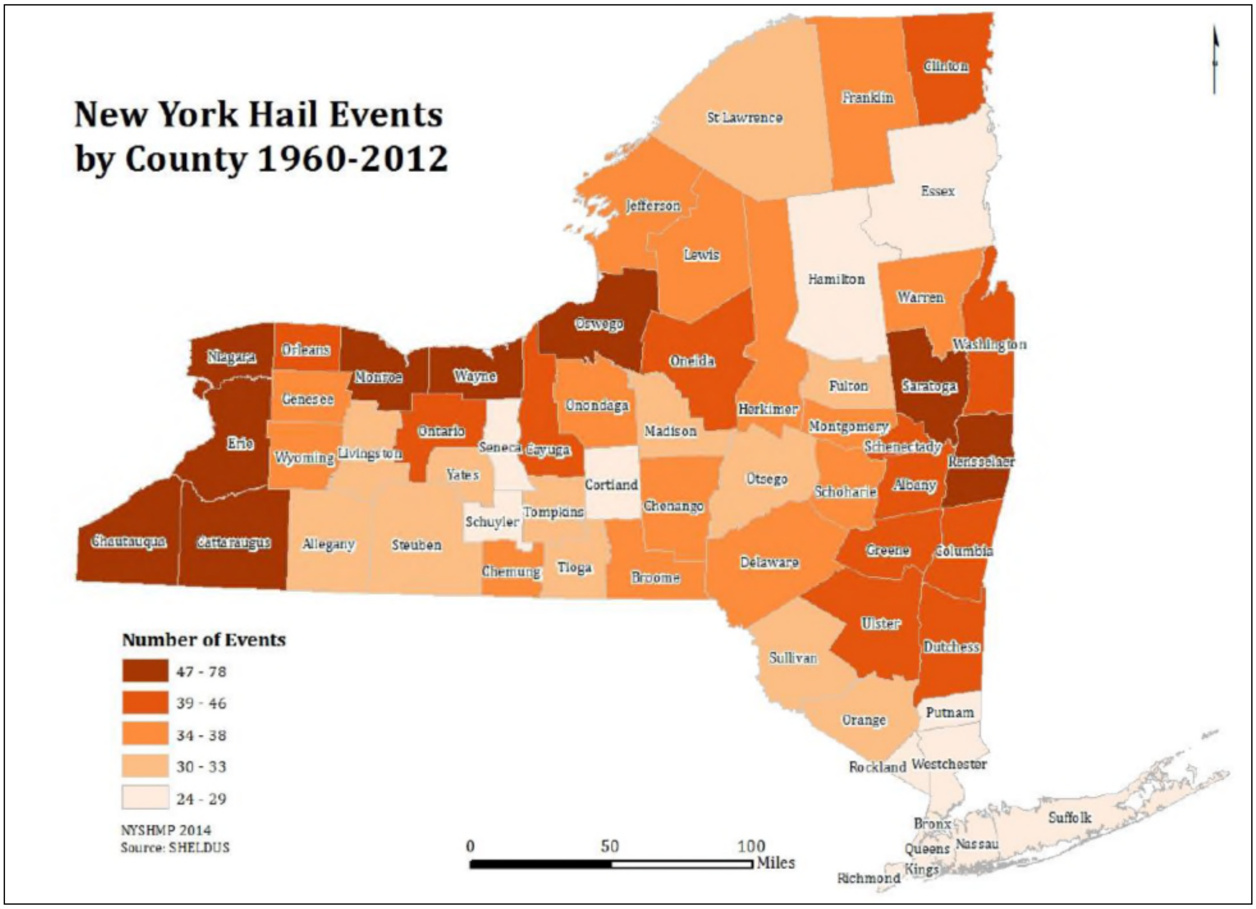



*Source: NSSL, 2003*

*Note: The mean number of days per year with one or more events within 25 miles of a point is shown here. The fill interval for tornadoes is 0.2, with the purple starting at 0.2 days. For the nontornadic threats, the fill interval is 1, with the purple starting at 1. For the significant (violent), it's 5 days per century (millennium)*

Figure 5.4.10-3 shows the number of hail events from 1960 to 2012 across New York State. The figure indicates that Suffolk County has experienced between 24 and 29 events during this timeframe (NYS DHSES, 2013).

**Figure 5.4.10-3. New York Hail Events by County, 1960 to 2012**

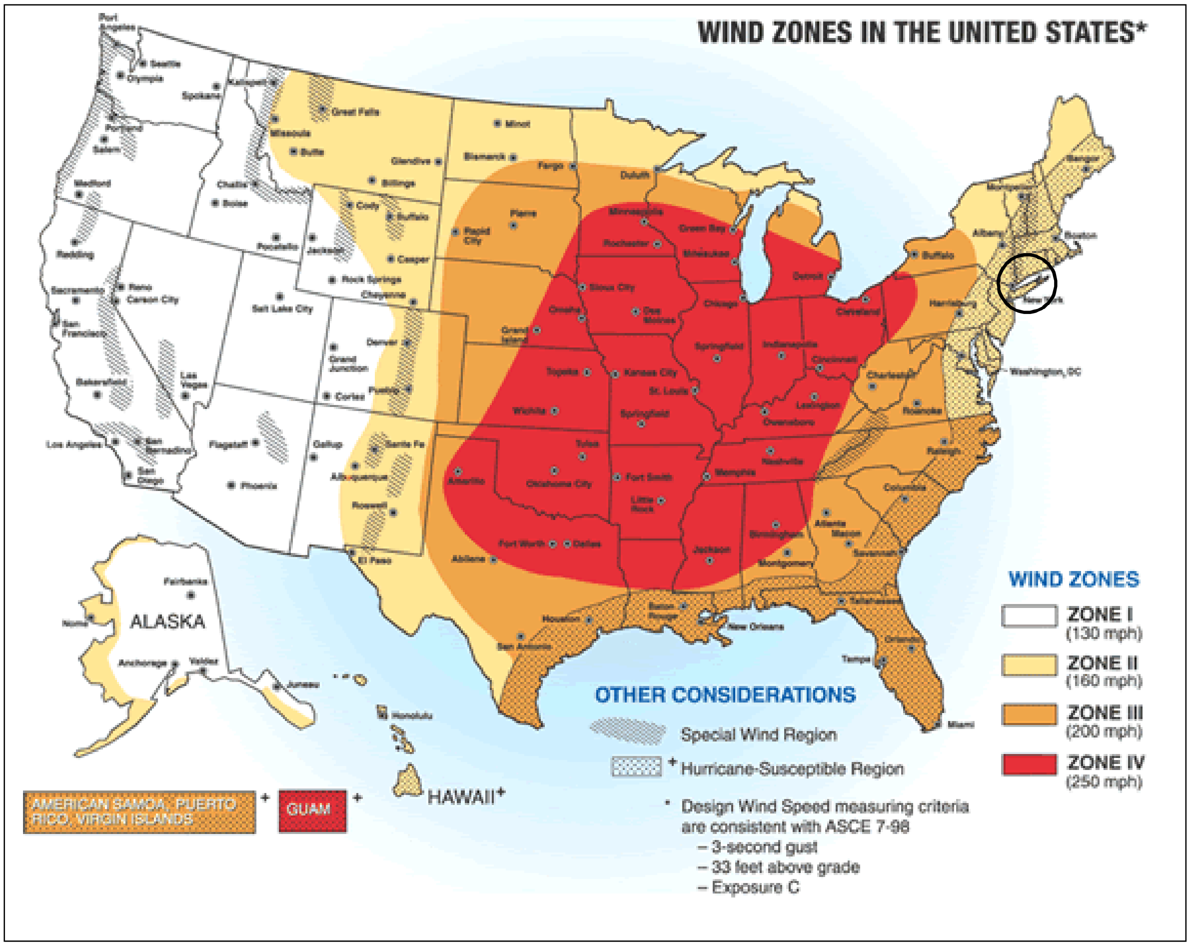



*Source: NYS DHSES, 2013*

## Windstorms

Figure 5.4.10-4 indicates how the frequency and strength of windstorms impacts the U.S. and the general location of the most wind activity. This is based on 40 years of tornado history and 100 years of hurricane history, collected by FEMA. States located in Wind Zone IV have experienced the greatest number of tornadoes and the strongest tornadoes (NVRC, 2006). Suffolk County is located in Wind Zone II with speeds up to 200 miles per hour. The County is also located within the hurricane susceptible region (FEMA, 2012).

### Figure 5.4.10-4. Wind Zones in the U.S.




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

### Table 5.4.10-5. Wind Zones in the U.S.

| Wind Zones | Areas Affected |
|---|---|
| Zone I (130 mph) | All of Washington, Oregon, California, Idaho, Utah, and Arizona. Western parts of Montana, Wyoming, Colorado and New Mexico. Most of Alaska, except the east and south coastlines. |
| Zone II (160 mph) | Eastern parts of Montana, Wyoming, Colorado, and New Mexico. Most of North Dakota. Northern parts of Minnesota, Wisconsin and Michigan. Western parts of South Dakota, Nebraska and Texas. All New England States. Eastern parts of New York, Pennsylvania, Maryland, and Virginia. Washington, DC. |
| Zone III (200 mph) | Areas of Minnesota, South Dakota, Nebraska, Colorado, Kansas, Oklahoma, Texas, Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Pennsylvania, New York, Michigan, and Wisconsin. Most or all of Florida, Georgia, South Carolina, North Carolina, Virginia, West Virginia. All of American Samoa, Puerto Rico, and Virgin Islands. |
| Zone IV (250 mph) | Mid US including all of Iowa, Missouri, Arkansas, Illinois, Indiana, and Ohio and parts of adjoining states of Minnesota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Pennsylvania, Michigan, and Wisconsin. Guam. |
| Special Wind Region | Isolated areas in the following states: Washington, Oregon, California, Idaho, Utah, |

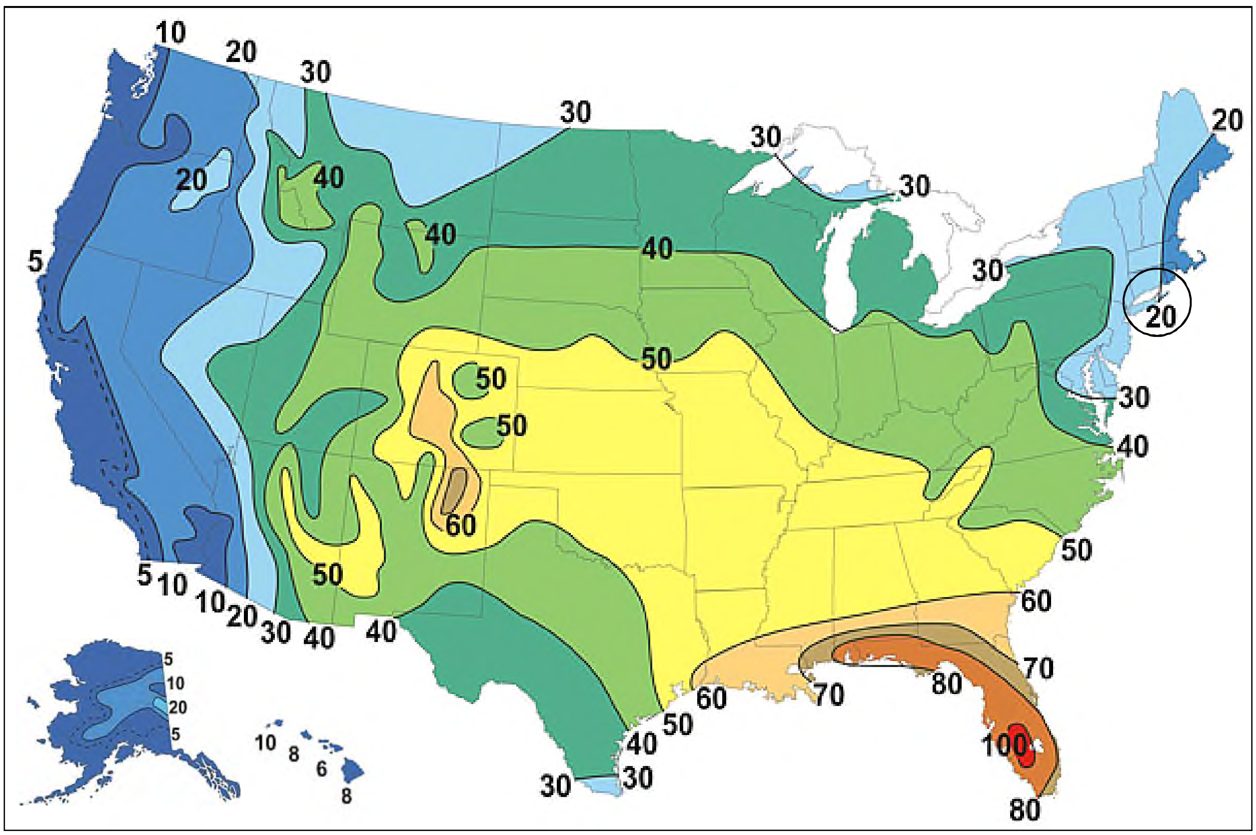
| Wind Zones | Areas Affected |
| --- | --- |
| | Arizona, Montana, Wyoming, Colorado, New Mexico. The borders between Vermont and New Hampshire; between New York, Massachusetts and Connecticut; between Tennessee and North Carolina. |
| Hurricane Susceptible Region | Southern US coastline from Gulf Coast of Texas eastward to include entire state of Florida. East Coastline from Maine to Florida, including all of Massachusetts, Connecticut, Rhode Island, Delaware, and Washington DC. All of Hawaii, Guam, American Samoa, Puerto Rico and Virgin Islands. |

*Source: NYS HMP, 2014*

## Thunderstorms

Thunderstorms affect relatively small localized areas, rather than large regions much like winter storms, and hurricane events (NWS, 2010). Thunderstorms can strike in all regions of the U.S.; however, they are most common in the central and southern states. The atmospheric conditions in these regions of the country are most ideal for generating these powerful storms (NVRC, 2006). It is estimated that there are as many as 40,000 thunderstorms each day world-wide. Figure 5.4.10-5 shows the average number of thunderstorm days throughout the U.S. The most thunderstorms are seen in the southeast states, with Florida having the highest incidences (80 to over 100 thunderstorm days each year) (NWS, 2010). This figure indicates that Suffolk County experiences between 20 and 30 thunderstorm days each year.

**Figure 5.4.10-5. Annual Average Number of Thunderstorm Days in the U.S.**

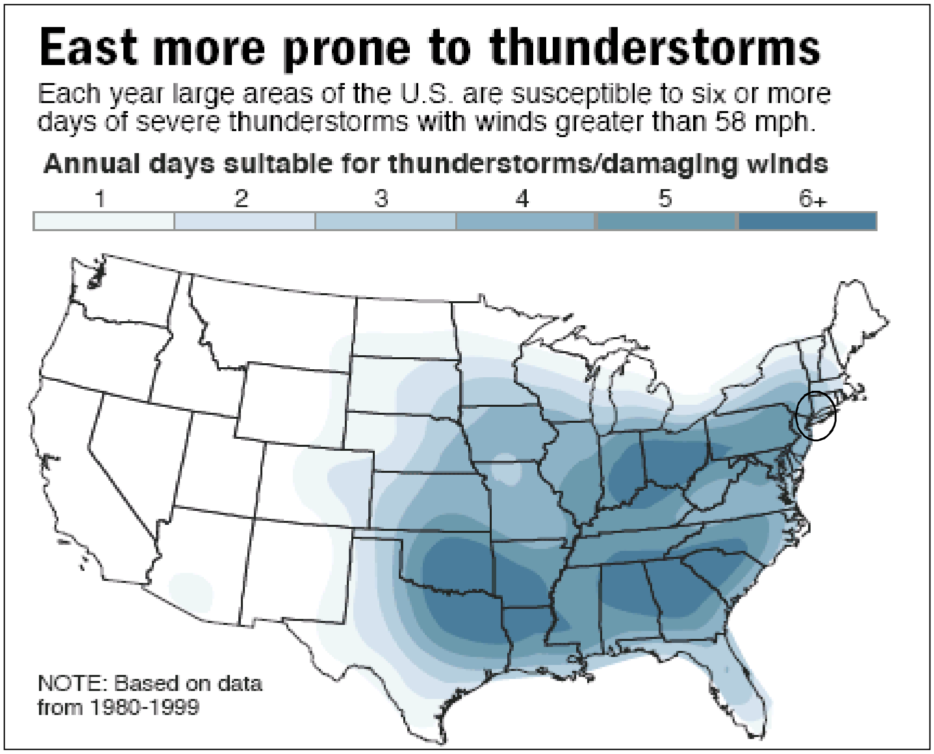



*Source: NWS, 2010*
*Note: The black circle indicates the approximate location of Suffolk County.*

NASA scientists suggest that the U.S. will face more severe thunderstorms in the future, with deadly lightning, damaging hail and the potential for tornadoes in the event of climate change (Borenstein, 2007).

A recent study conducted by NASA predicts that smaller storm events like thunderstorms will be more dangerous due to climate change (Figure 5.4.10-6). As prepared by the NWS, Figure 5.4.10-5 identifies those areas, particularly within the eastern U.S. that are more prone to thunderstorms, which includes New York State and Suffolk County.

**Figure 5.4.10-6. Annual Days Suitable for Thunderstorms/Damaging Winds**

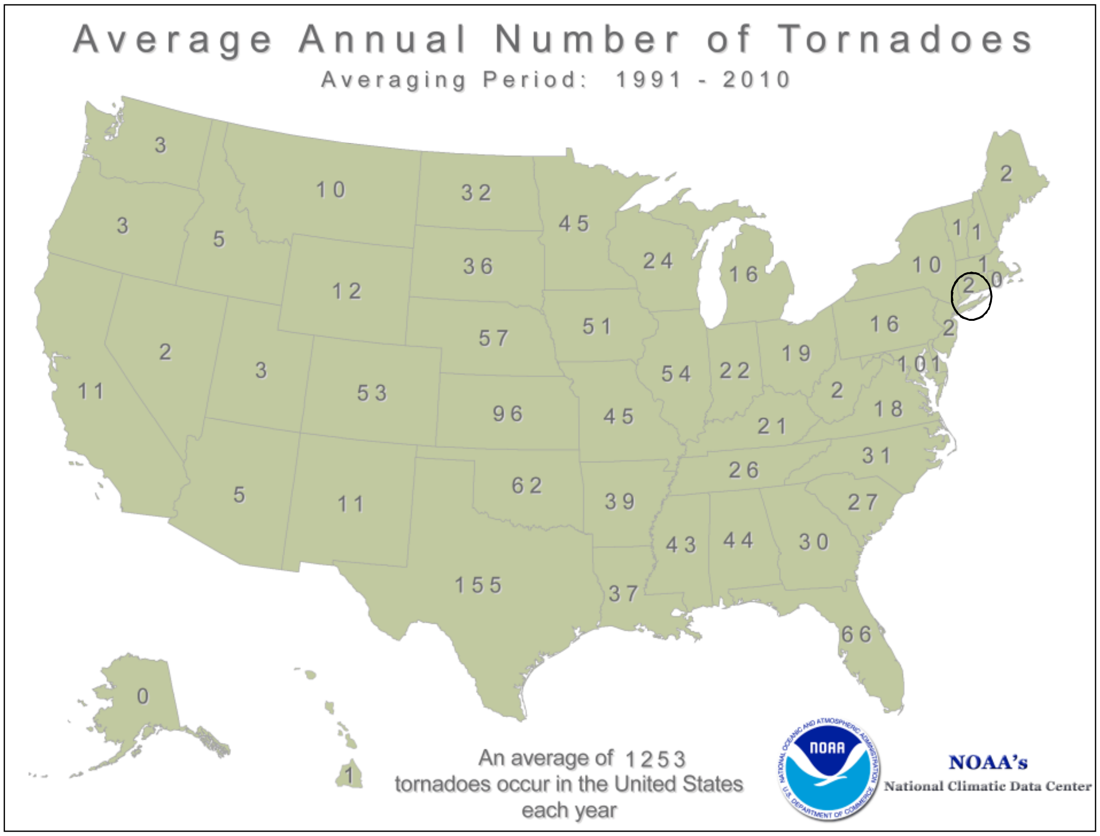



*Source: NBCNews.com, 2007*

## Tornado

The U.S. experiences more tornadoes than any other country. In a typical year, an average of 1,253 tornadoes occur in the U.S. The peak of the tornado season is April through June, with the highest concentration of tornadoes in the central U.S. Figure 5.4.10-7 shows the annual average number of tornadoes between 1991 and 2010 (NWS, 2011). New York State experienced an average of 10 tornado events annually between 1991 and 2010.

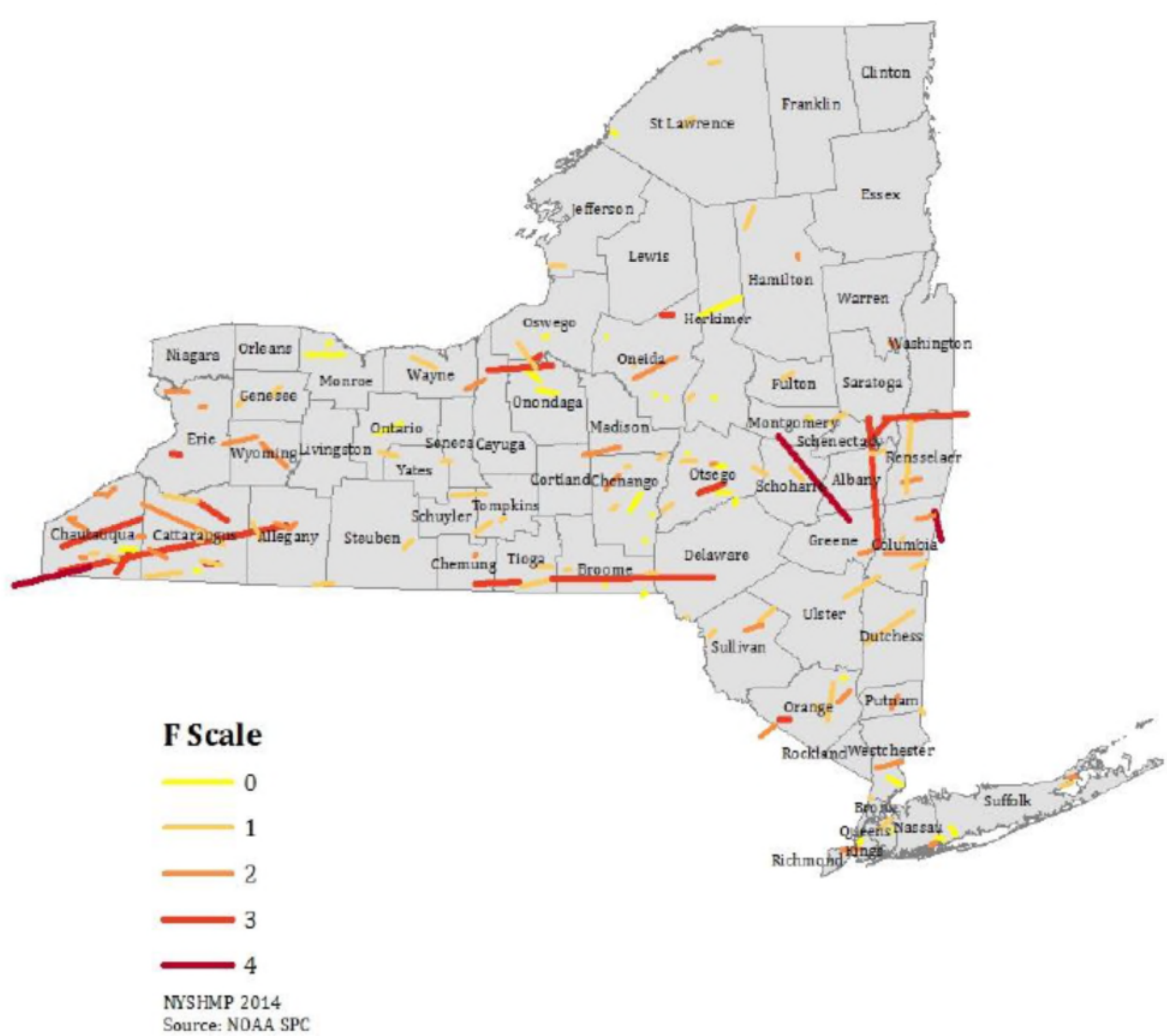
**Figure 5.4.10-7. Annual Average Number of Tornadoes in the U.S., 1991-2010**




*Source: NCDC, 2013*
*Note: Between 1991 and 2010, New York State experienced an average of 10 tornadoes each year.*

New York State ranks 30th in the U.S. for frequency of tornadoes. When compared to other states on the frequency of tornadoes per square mile, the State ranks 35th (The Disaster Center, Date Unknown). New York State has a definite vulnerability to tornadoes and can occur, based on historical occurrences, in any part of the State. Figure 5.4.10-8 shows historical straight-path tornado tracks for New York State between 1960 and 2012. The figure indicates that Suffolk County has experienced F0, F1, and F2 tornadoes (NYS DHSES, 2013).

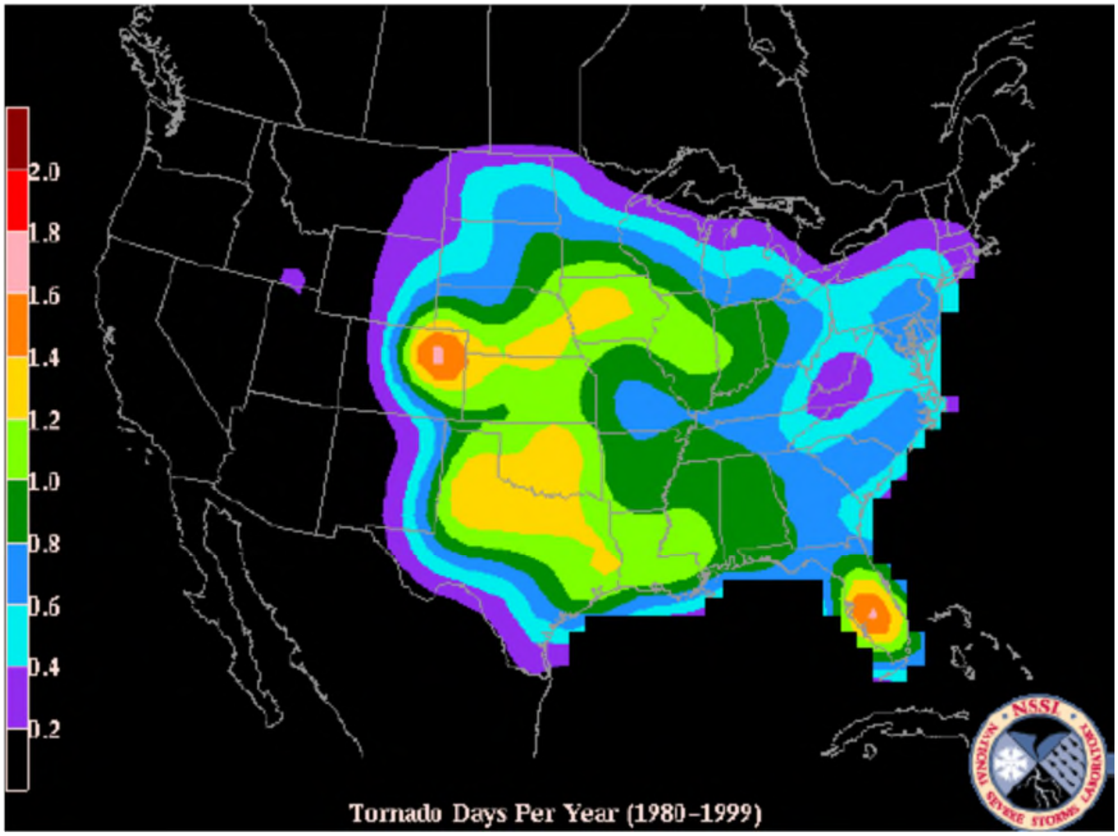
**Figure 5.4.10-8. Historical Tornado Tracks in New York State, 1960-2012**




*Source: NYS DHSES, 2013*

A study from NOAA's National Severe Storms Laboratory (NSSL) provided estimates of the long-term threat from tornadoes. The NSSL used historical data to estimate the daily probability of tornado occurrences across the U.S., no matter the magnitude of the tornado. Figure 5.4.10-9 shows the estimates prepared by the NSSL. In New York State, it is estimated that the probability of a tornado occurring is 0 and 0.6 days per year. In Suffolk County, it is estimated that the probability of tornado occurring is 0.2 to 0.6 days per year (NYS DHSES, 2011).

**Figure 5.4.10-9. Total Annual Threat of Tornado Events in the U.S., 1980-1999**




*Source: NSSL, 2003*
*Note: The mean number of days per year with one or more events within 25 miles of a point is shown here. The fill interval for tornadoes is 0.2, with the purple starting at 0.2 days. For the nontornadic threats, the fill interval is 1, with the purple starting at 1. For the significant (violent), it's 5 days per century (millennium)*

## Previous Occurrences and Losses

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

The NYS HMP indicated that Suffolk County has experienced 26 hailstorm events between 1960 and 2012. Those events caused three injuries and over $66,000 in property damage and over $4,000 in crop damage. Between 1960 and 2012, the County experienced 151 high wind events that caused nine fatalities, 25 injuries, over $7 million property damage and over $300 in crop damage. Of those 290 events, 67 of them have occurred between 2010 and 2012 (four fatalities, one injury, over $5 million in property damage) (NYS DHSES, 2013).

According to NOAA-NCDC storm events database, Suffolk County experienced 184 severe storm events (funnel cloud, hail, high wind, lightning, precipitation, strong winds, thunderstorms, and tornadoes) between 2008 and 2013. Total property damages were estimated at over $5.8 million, four deaths and five injuries.

The Hazard Research Lab at the University of South Carolina's Spatial Hazard Events and Losses Database for the U.S. (SHELDUS) is a county-level hazard data set for the U.S. for 18 different natural hazard event types (avalanche, coastal, drought, earthquake, flooding, fog, hail, heat, hurricane/tropical storm, landslide, lightning, severe storm/thunderstorm, tornado, tsunami/seiche, volcano, wildfire, wind, and winter weather). Currently, the database includes every loss causing and/or deadly event between 1960 and 1992 and from 1995 onward. Between 1993 and 1995, SHELDUS reflects only events that caused at least one fatality or more than $50,000 in property or crop damages. Therefore, the numbers provided by SHELDUS do not represent all severe storm weather events that occurred in Suffolk County. According to SHELDUS, between 2008 and 2013, 96 events occurred within the County. These events resulted in four fatalities, six injuries, and $6.4 million in property damage.

Between 1954 and 2013, FEMA declared that New York State experienced 37 severe storm-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe storms, heavy rain, high winds, 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 other sources indicate that Suffolk County has been declared as a disaster area as a result of seven severe storm events (FEMA, 2013).

For this 2014 Plan Update, known severe storm events that have impacted Suffolk County between 2008 and 2013 are identified in Table 5.4.10-6. Events identified in the 2007 Plan are included in Appendix H. With severe storm documentation for New York State and Suffolk County being so extensive, not all sources have been identified or researched. Therefore, Table 5.4.10-6 may not include all events that have occurred in the County. Please note hazard events of hurricanes and Nor'Easters will be addressed specifically in Sections 5.4.7 and 5.4.9.

**Table 5.4.10-6. Severe Storm Events Between 2008 and 2013**

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts |
|---|---|---|---|---|
| March 5, 2008 | TSTM / Wind | N/A | N/A | Trees and wires were reported down across roadways in Wading River. Monetary damages were not recorded. |
| June 16, 2008 | TSTM / Wind | N/A | N/A | Severe thunderstorms caused trees and wires down in the Village of Northport and the hamlet of Manorville. $52 K in damages were reported. |
| June 23, 2008 | TSTM / Wind | N/A | N/A | A severe thunderstorm downed trees, resulting in $12 K in damages in the hamlet of Mattituck and the town of Southold. |
| July 27, 2008 | Hail; TSTM; Wind | N/A | N/A | Severe thunderstorms resulted in a lightning strike that caused a major house fire in the town of Huntington. $100 K in damages were reported. |
| August 2, 2008 | TSTM / Wind | N/A | N/A | Trees were downed onto power lines, causing $1 K in damages in the town of Southampton. |
| August 7, 2008 | TSTM / Wind; Hail | N/A | N/A | Thunderstorm winds sent a tree limb into a house in the hamlet of Jamesport, causing $20 K in damages. |
| August 15, 2008 | Hail | N/A | N/A | A severe thunderstorm caused nearly $35 K in wind, hail, and lightning damages to the New York City Metro Area and Long Island, including Suffolk County. |
| December 31, 2008 | High Wind | N/A | N/A | The combination of strong high pressure over the midwest and intense low pressure well east of Long Island, produced northwest winds of 40 to 50 mph. A sustained wind of 43 mph was measured at Shinnecock Light Tower in the hamlet of Hampton Bays. |
| February 12, 2009 | High Wind | N/A | N/A | An intense area of low pressure area tracked northeast, and high winds developed near daybreak. Suffolk County experienced 60 mph at Islip High school (town of Islip). Winds downed trees and power line, causing over 4000 power outages across Long Island. Monetary damages were not recorded. |
| April 3, 2009 | Lightning | N/A | N/A | Thunderstorms resulted in a lightning strike that destroyed a home in the village of Sagaponack. $800 K in damages were reported. |
| July 7, 2009 | TSTM / Wind | N/A | N/A | Severe thunderstorms caused over $1 M in damages across Connecticut, the Lower Hudson Valley of New York, and Long Island. Of that, only $2,500 in damages were reported in Suffolk County. |

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts |
|---|---|---|---|---|
| July 31, 2009 | TSTM / Wind | N/A | N/A | Severe thunderstorms downed trees, causing $1,500 in damages. |
| September 28, 2009 | TSTM / Wind | N/A | N/A | Thunderstorms caused $1 K in damages due to downed trees and wires in the hamlet of Dix Hills. |
| October 7, 2009 | Strong Wind | N/A | N/A | Following the passage of a strong cold front, strong west winds developed. Peak gusts ranged from around 45 mph to 55 mph and caused scattered power outages. Peak wind gusts were measured at 46 mph at the village of Westhampton Beach Airport. $6 K in damages were reported throughout the county. |
| November 12-14, 2009 | Severe Storms and Flooding (Remnants of Tropical Storm Ida and a Nor'Easter) | DR-1869 | Yes | Severe storms and coastal flooding caused an estimated $17 M in damages. Severe beach erosion and cuts into the dunes occurred along the Atlantic Ocean facing beaches. Monetary damages were not recorded. |
| November 28, 2009 | Strong Wind | N/A | N/A | Strong winds downed trees, causing $5 K in damages in to a pickup truck in the hamlet of Stony Brook. |
| December 9, 2009 | High Wind | N/A | N/A | A tight pressure gradient ahead of a cold front produced strong southerly winds. A 60 mph peak wind speed was measured in the hamlet of Shinnecock Hills. |
| December 29, 2009 | High Wind | N/A | N/A | Strong winds downed power lines, causing $5 K in damages in to a pickup truck in the hamlet of North Babylon. |
| January 25, 2010 | High Wind | N/A | N/A | Winds downed numerous trees. $110 K in property damages were reported in the northeast part of the county, in part due to a tree that fell on a pickup truck in the town of Smithtown. |
| March 13-31, 2010 | Severe Storms and Flooding | DR-1899 | Yes | Between March 12th and 15th, rainfall totals in Suffolk County ranged between 2.26 inches and 4.93 inches. Wind gusts ranged between 47 mph and 69 mph. A tree fell on and killed a woman in the hamlet of Bay Shore.<br><br>Between March 22nd and 23rd, rainfall totals in Suffolk County ranged between 0.85 inches and 1.82 inches.<br><br>Between March 29th and 31st, rainfall totals for Suffolk County ranged between 4.33 inches and 8.83 inches.<br><br>FEMA issued a disaster declaration for this event and Suffolk County was included |

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts |
|---|---|---|---|---|
| | | | | in this declaration. Suffolk County was approved for PA. FEMA approved $86,529,838.16 in PA grant assistance. |
| June 22, 2010 | TSTM / Wind | N/A | N/A | $2,500 in property damages from downed trees were reported in the hamlet of Holbrook. |
| June 24, 2010 | TSTM / Wind | N/A | N/A | Severe thunderstorms caused nearly $500 K in damages across the Lower Hudson Valley of New York, New York City, and Long Island. Of that, $14 K in damages were reported in Suffolk County. |
| July 19, 2010 | TSTM / Wind | N/A | N/A | Multiple severe thunderstorms caused over $122 K in damages across southeast New York. Downed trees caused nearly $9 K in damages in Suffolk County. |
| July 21, 2010 | TSTM / Wind | N/A | N/A | Severe thunderstorms downed trees and power lines across southeast New York. $41 K in damages were reported in Suffolk County. |
| July 25, 2010 | TSTM / Wind; Hail | N/A | N/A | Severe thunderstorms caused nearly $200 K in damages across southeast New York. Over $22 K in damages were reported in Suffolk County. |
| September 8, 2010 | TSTM / Wind | N/A | N/A | Severe thunderstorms downed trees and wires. $3 K in damages were reported in East Hampton Village. |
| September 30 – October 1, 2010 | Strong Wind | N/A | N/A | A strong low pressure system approached from the south and caused strong wind gusts ranging from around 40 to 55 mph across the area. Strong winds were responsible for the loss of power to approximately 1,800 customers in Nassau and western Suffolk Counties due to downed power lines and trees. $140 K in property damages were recorded, $260 K of which were in Suffolk County. |
| October 15, 2010 | Strong Wind | N/A | N/A | Strong winds occurred ahead of and behind a cold front. A mesonet observation reported a wind gust to 58 mph at the hamlet of Shinnecock Hills. Strong winds knocked down some trees and tree limbs, which caused scattered power outages. $40 K in property damages in Suffolk County were recorded. |
| February 19, 2011 | High Wind | N/A | N/A | High winds resulted in downed trees and limbs throughout the southwest parts of the county. $100 K in damages were reported. |
| February 25, 2011 | High Wind | N/A | N/A | A strong low pressure system tracked east across the area. A wind gust up to 59 mph was reported at the hamlet of Shinnecock Hills. These winds resulted in downed trees or tree limbs across portions of the entire area. $100 K in property damages were recorded |

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts |
|---|---|---|---|---|
| June 17, 2011 | TSTM / Wind | N/A | N/A | Severe thunderstorms downed trees and wires. $6 K in damages were reported in the town of Huntington and the hamlet of Hauppauge. |
| July 7, 2011 | TSTM / Wind | N/A | N/A | A severe thunderstorm downed trees and wires. $5,500 K in damages were reported in the hamlets of Central Islip and Middle Island, and the village of Westhampton Beach. |
| July 26, 2011 | TSTM / Wind | N/A | N/A | Severe thunderstorms caused trees down across the town of Southampton. $5 K in damages were reported. |
| August 1, 2011 | TSTM / Wind | N/A | N/A | Severe thunderstorms caused over $214 K in damages across southeast New York. Suffolk County suffered over $66 K in damages to Babylon, the hamlets of Baiting Hollow, Calverton, Hampton Bays, and Westhampton, and the village of Westhampton Beach. |
| August 18, 2011 | TSTM / Wind; Hail | N/A | N/A | Severe thunderstorms caused trees and wires down. $3,750 in damages were reported in the hamlets of Sayville and North Patchogue, and the village of Patchogue. |
| August 28, 2011 | Tornado | N/A | N/A | Tropical Storm Irene spawned a tornado in southwest Suffolk County. Property damages were not reported. |
| December 8, 2011 | High Wind | N/A | N/A | High winds overturned a construction trailer in the village of Shoreham. $10 K in property damages were reported. |
| December 27, 2011 | High Wind | N/A | N/A | High winds caused $20 K in damages to the Islip Macarthur Airport. |
| June 3, 2012 | TSTM / Wind | N/A | N/A | Severe thunderstorms caused trees and wires down. $4,500 in damages were reported in the hamlets of Commack and West Islip, and the town of Islip. |
| July 1, 2012 | TSTM / Wind; Hail | N/A | N/A | A severe thunderstorm downed trees and wires. $7,500 in damages were reported in the hamlet of West Sayville. |
| July 7, 2012 | TSTM / Wind | N/A | N/A | Severe storms downed trees and wires in Middle Island and Westhampton Beach, causing $4 K in damages. |
| July 15, 2012 | TSTM / Wind | N/A | N/A | Severe thunderstorms caused trees and wires down. $3 K in damages were reported in the hamlet of Mt. Sinai. |

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts |
|---|---|---|---|---|
| August 10, 2012 | TSTM / Wind | N/A | N/A | An EF0 tornado touched down on Widgeon Court in the hamlet of Great River, and tracked north-northeast to where it lifted near the intersection of Ocean Avenue and Gary Way Road in the hamlet of Ronkonkoma.<br><br>The track went through the hamlet of Oakdale, Connequot River State Park, Bohemia County Park, and the hamlet of Bohemia in between touch down and lifting. The most significant damage occurred between 8th Street and Feuereisen Avenue in the hamlet of Bohemia around 2:11 PM EDT. Multiple trees were uprooted and thrown onto power lines. Several homes were damaged due to fallen trees in the hamlets of Oakdale and Bohemia. There were several eyewitness reports of the tornado moving north-northeast near the east bank of the Connequot River and in the hamlet of Bohemia as well.<br><br>$100 K in property damages were reported. |
| August 15, 2012 | Tornado; TSTM | N/A | N/A | New York City and Long island experienced flooding and downed trees and power lines from high winds. The hamlet of Westhampton measured 2.19 inches of rainfall Wind gusts of 60 mph were reported in the hamlet of Melville. Monetary damages were not recorded. |
| September 18, 2012 | TSTM / Wind | N/A | N/A | Severe thunderstorms caused trees and wires down. $2 K in damages were reported in the village of Lake Grove. |
| September 28, 2012 | TSTM / Wind | N/A | N/A | Severe thunderstorms caused trees and wires down. $2 K in damages were reported in the hamlet of Eatons Neck. |
| October 29, 2012 | Post-tropical Storm Sandy | DR-4085 / EM-3351 | Yes | In Suffolk County, maximum wind gusts ranged between 66 mph (East Hampton) to 96 mph (Eatons Neck). A high surf advisory was issued prior to the storm for the south shore of Long Island and a coastal flood warning was issued.<br><br>In Commack, a 57 year old homeless female was killed when a tree fell on her tent. In Nissequogue, a male, age unknown, was killed by a fallen tree limb. In Hauppauge, a 66 year old male was killed when he cut down a tree, and it fell on him on November 6th. In Lloyd Harbor a 39 year old male was killed by a fallen tree. $4 M in wind damages were recorded throughout the county.<br><br>FEMA issued a disaster declaration for several counties in New York State, including Suffolk County. Suffolk County was approved for IA and PA. FEMA approved $944,478,644.95 in IA for the State and $816,955,000.39 in total PA grants. |

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts |
|---|---|---|---|---|
| | | | | Flooding impacts for this event are described in Section 5.4.7: Hurricane Hazard Profile. |
| November 7, 2012 | High Wind | N/A | N/A | High winds snapped power and phone lines in the northern part of the county. $400 K in property damages were reported in Suffolk County. |
| December 26-27, 2012 | High Wind | N/A | N/A | Strong winds caused $2 K in damages in the northwest parts of the county. |
| January 31, 2013 | High Wind | N/A | N/A | Strong winds downed trees and power lines, causing $150 K in damages in the county. |
| February 27, 2013 | High Wind | N/A | N/A | Strong winds caused $10 K in damages in the southwest parts of the county. |
| March 6, 2013 | High Wind | N/A | N/A | Strong winds caused $2 K in damages in the southern parts of the county. |

*Sources:* *FEMA, 2013; NOAA-NCDC, 2013; NWS, 2013; SHELDUS, 2013*
*Note:* *Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of inflation.*
*DR* *Federal Disaster Declaration*
*EM* *Federal Emergency Declaration*
*FEMA* *Federal Emergency Management Agency*
*IA* *Individual Assistance*
*K* *Thousand ($)*
*M* *Million ($)*
*Mph* *Miles Per Hour*
*NCDC* *National Climate Data Center*
*NOAA* *National Oceanic Atmospheric Administration*
*NYS* *New York State*
*NWS* *National Weather Service*
*PA* *Public Assistance*
*SHELDUS* *Spatial Hazard Events and Losses Database for the U.S.*
*TSTM* *Thunderstorms*

## 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 particularly difficult because of the region's geographic location. It is positioned roughly halfway between the equator and the North Pole and 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).

In Section 5.3, the identified hazards of concern for Suffolk 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 5.3-3).

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

## Climate Change Impacts

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already being felt in the State. ClimAID: the Integrated Assessment for Effective Climate Change in New York State (ClimAID) was undertaken to provide decision-makers with information on the State's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (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. Suffolk County is part of Region 4, New York City and Long Island. Some of the issues in this region, affected by climate change, include: the area contains the highest population density in the State; sea level rise and storm surge increase coastal flooding, erosion, and wetland loss; challenges for water supply and wastewater treatment; increase in heat-related deaths; illnesses related to air quality increase; and higher summer energy demand stresses the energy system (NYSERDA, 2011).

Temperatures and precipitation amounts are expected to increase throughout the State, as well as in Region 4. It is anticipated that by the 2020s, the State's temperature will rise between 1.5 and 3ºF; 3 to 5.5ºF by the 2050s; and 4 to 9ºF by the 2080s. The lower ends of these ranges are for lower greenhouse gas emissions scenarios and the higher ends for higher emission scenarios (NYSERDA, 2011).

In Region 4, it is estimated that temperatures will increase by 3ºF to 5ºF by the 2050s and 4ºF to 7.5ºF by the 2080s (baseline of 53ºF). Precipitation totals will increase between 0 and 10% by the 2050s and 5 to 10% by the 2080s (baseline of 43 inches). Table 5.4.10-7 displays the projected seasonal precipitation change for the New York City and Long Island ClimAID Region (NYSERDA, 2011).

**Table 5.4.10-7. Projected Seasonal Precipitation Change in Region 4, 2050s (% change)**

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

*Source: NYSERDA, 2011*

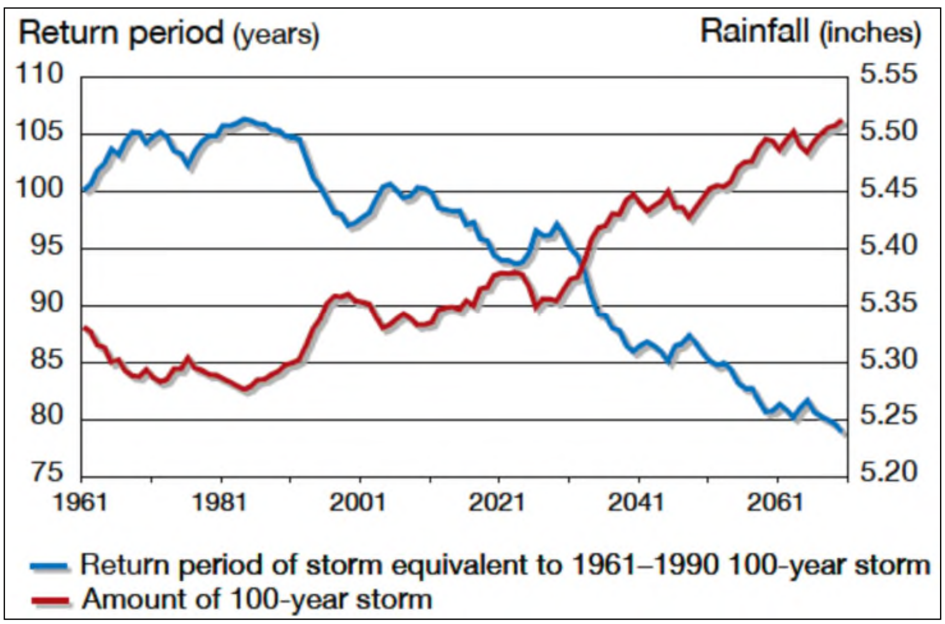
The projected increase in precipitation is expected to fall in heavy downpours and less in light rains. The increase in heavy downpours has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways and transportation hugs; and increase delays and hazards related to extreme weather events (NYSERDA, 2011).

Increasing air temperatures intensify the water cycle by increasing evaporation and precipitation. This can cause an increase in rain totals during events with longer dry periods in between those events. These changes can have a variety of effects on the State's water resources (NYSERDA, 2011).

Over the past 50 years, heavy downpours have increased and this trend is projected to continue. This can cause an increase in 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 (NYSERDA, 2011).

Figure 5.4.10-10 displays the project rainfall and frequency of extreme storms in New York State. The amount of rain fall in a 100-year event is projected to increase, while the number of years between such storms (return period) is projected to decrease. Rainstorms will become more severe and more frequent (NYSERDA, 2011).

**Figure 5.4.10-10. Projected Rainfall and Frequency of Extreme Storms**




*Source: NYSERDA, 2011*

Total precipitation amounts have slightly increased in the Northeast U.S., by approximately 3.3 inches over the last 100 years. There has also been an increase in the number of two-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).

## Vulnerability Assessment

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

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety 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 Suffolk County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

### Overview of Vulnerability

People and property in virtually the entire United States are exposed to damage, injury, and loss of life from severe storm events (thunderstorms, lightning, wind, hail, tornadoes). Everywhere they occur; thunderstorms are responsible for significant structural damage to buildings, forest and wildfires, downed power lines and trees, and loss of life. For the purposes of this HMP, the entire County is exposed to severe storm events. Refer to Section 5.4.7 (Hurricane) for a detailed and quantitative assessment on the wind and storm surge hazards. The section below discusses severe storm events in a qualitative nature.

### Data and Methodology

The 2010 U.S. Census population and general building stock data were used to support an evaluation of assets exposed to this hazard and the potential impacts associated with this hazard. Refer to Section 5.4.7 (Hurricane) for additional information on the methodology pertaining to the wind and storm surge impacts.

### Impact on Life, Health and Safety

For the purposes of this HMP, the entire population of Suffolk County (1,493,350 people) is exposed to severe storm events (U.S. Census, 2010). Residents may be displaced or require temporary to long-term sheltering due to severe weather events. 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.

People located outdoors (i.e., recreational activities and farming) are considered most vulnerable to hailstorms, thunderstorms and tornadoes. This is because there is little to no warning and shelter may not be available. Moving to a lower risk location will decrease a person's vulnerability.

Whether for extreme heat or extreme cold, vulnerable populations include the homeless population, elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Refer to Section 4 (County Profile) for population statistics for each participating jurisdiction.

### Impact on General Building Stock and Critical Facilities

Damage to buildings is dependent upon several factors including wind speed and duration, and building construction. Refer to Section 5.4.7 (Hurricane) for a presentation on potential wind losses associated with 100- and 500-year mean return period events. Damage will result from hail stones themselves and will have a specific impact on roofs. The extent of damage will depend on the size of the hailstorm.

### Impact on Economy

As discussed, severe storm events can impact structures and the economy. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the population.

As a result of extreme temperature events, business owners may be faced with increased financial burdens due to unexpected repairs such as pipes bursting, higher than normal utility bills or business interruption due to power failure (i.e., loss of electricity, telecommunications). Increased demand for water and electricity may result in shortages and a higher cost for these resources. Industries that rely on water for business operations and services may be impacted the hardest during extreme heat events (e.g., landscaping businesses). Even though most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the recreation and tourism industry.

Agricultural losses can be devastating due to lightning and resulting fires, hailstorms and extreme temperature events. Suffolk County has 585 farms that produce products valued at over $242 million annually.

### Future Growth and Development

As discussed in Sections 4 and 9, areas targeted for future growth and development have been identified across the Planning Area. Any areas of growth could be potentially impacted by the severe storm hazard because the entire planning area is exposed and vulnerable. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

### Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of severe storm events that may be associated with increases in temperatures. While predicting changes to the impacts of severe storms under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

### Change of Vulnerability

Overall, the County's vulnerability has not changed and the entire County will continue to be exposed and vulnerable to severe storm events.

## Additional Data and Next Steps

The collection of additional/actual valuation data for general building stock, critical infrastructure and economic losses would further support future estimates of potential exposure and damage for these inventories and the economy.