11. SEVERE WEATHER

11.1 Hazard Profile

11.1.1 Hazard Description

The severe weather hazard for this HMP update includes thunderstorms and lightning, high winds, hailstorms, tornadoes, and hurricanes (including storm surge).

THUNDERSTORMS AND LIGHTNING

A thunderstorm is a local storm accompanied by lightning and thunder (NWS 2021). It 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. 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 National Weather Service (NWS) considers a thunderstorm severe only if it produces damaging wind gusts of at least 58 miles per hour (mph), hail of at least one-inch diameter, or tornadoes. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the United States, with approximately 10 percent of them classified as severe (NWS 2016).

Lightning is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. Lightning can damage homes and injure people. In the United States, an average of 300 people are injured and 80 people are killed by lightning each year. Lightning can occur anywhere there is a thunderstorm and can travel via cloud-to-air, cloud-to-cloud (i.e., “intra-cloud”), and cloud-to-ground (NOAA 2014).

HIGH WINDS

Wind is horizontal movement of air caused by uneven heating of the earth’s surface. It occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated by other severe weather events such as thunderstorms, tornadoes, hurricanes, and tropical storms (NWS 2012). Straight-line wind is a term used to define any thunderstorm wind that is not associated with rotation and is used mainly to differentiate from tornadic winds. It includes the following (NOAA 2023):

- A **microburst** is a small, concentrated downburst that produces an outward burst of strong winds at or near the surface. Microbursts are typically less than 2.5 miles across and short-lived, lasting only five to 10 minutes, with maximum windspeeds sometimes exceeding 100 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- A **derecho** is a widespread, long-lived windstorm that is associated with a band of rapidly moving showers or thunderstorms. A derecho is defined as an event with a wind damage swath extending more than 240 miles that includes wind gusts of at least 58 mph or greater along most of its length. A typical derecho consists of numerous microbursts, downbursts, and downburst clusters.

HAILSTORMS

Hail forms inside a thunderstorm where there are strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32 degrees Fahrenheit (°F) or colder. As the frozen droplet begins to fall, it might thaw as it moves into warmer air toward the bottom of the thunderstorm, or the droplet might be picked up again by another updraft and carried back into the cold air to re-freeze. With each trip above and below the freezing level, the frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail (NSSL 2021).

TORNADOES

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

HURRICANES

A hurricane is a tropical cyclone that attains hurricane status when its wind speed reaches at least 74 mph. A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or sub-tropical waters and has a closed low-level circulation. Tropical depressions, tropical storms, and hurricanes are all considered tropical cyclones. These storms rotate counterclockwise around the center in the northern hemisphere and are accompanied by heavy rain and strong winds (NOAA 2023). Almost all tropical storms and hurricanes in the Atlantic Basin (which includes the Gulf of Mexico and Caribbean Sea) form between June and November, officially referred to as hurricane season. August and September are peak months for hurricane development in the North Atlantic Basin (NHC 2020)

Tropical cyclones strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. They are fueled by a different heat mechanism than other cyclonic windstorms, such as nor'easters and polar lows. The characteristic that separates tropical cyclones from other cyclonic systems is that at any height in the atmosphere, the center of a tropical cyclone will be warmer than its surroundings, which is called a "warm core" storm system (NOAA 2023).

During hurricanes, storm surge causes backwater flooding by causing rising water elevations at coastal river mouths. Strong winds can increase tide levels and water-surface elevations in the connected bodies of water. Storm systems generate large waves that run up and can push high amounts of water inland along waterways opposite the direction of their typical flow, which can overtop banks and impact adjacent low-lying floodplains.

11.1.2 Location

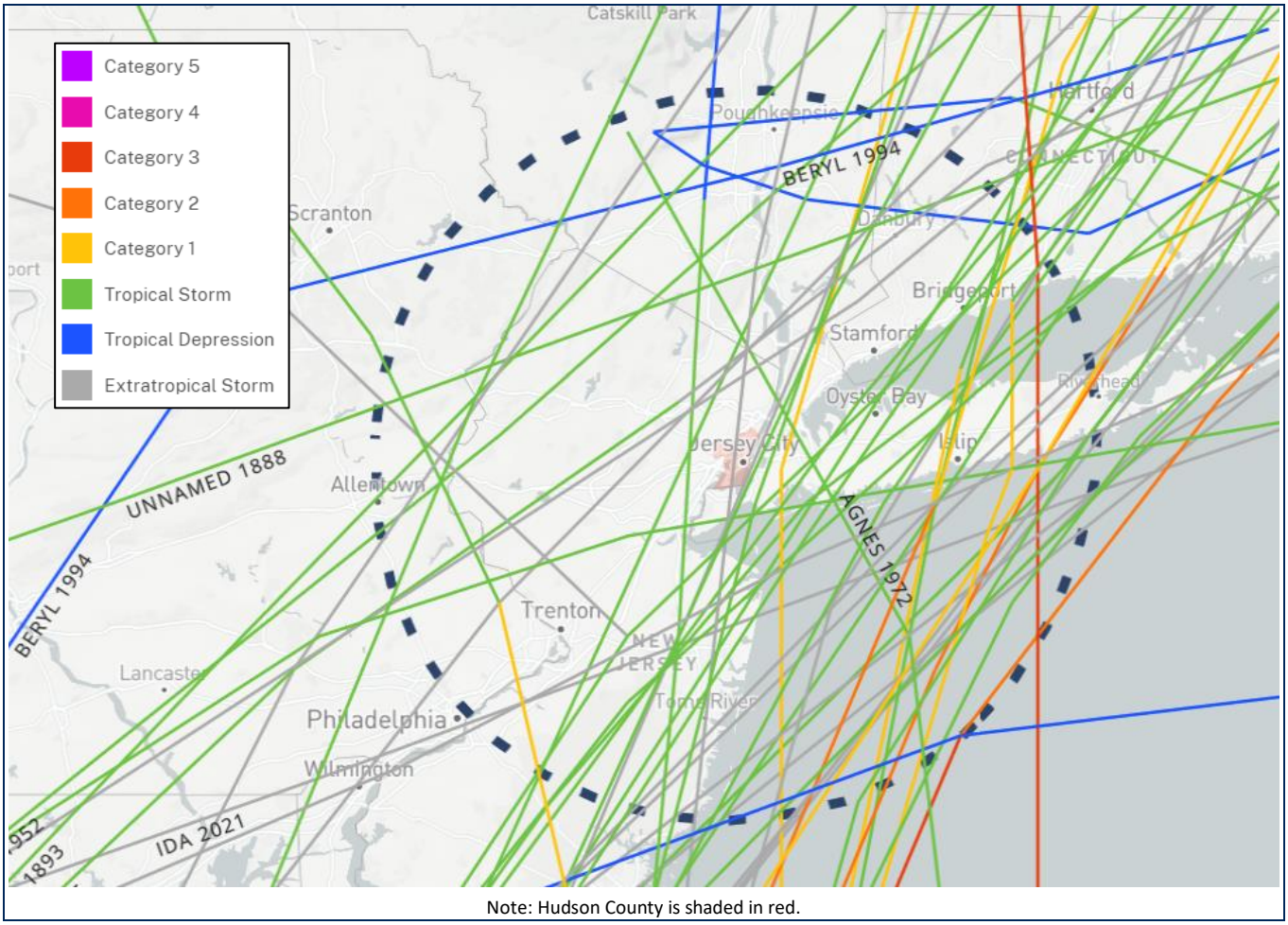
THUNDERSTORMS AND LIGHTNING, HIGH WINDS, HAILSTORMS, AND TORNADOES

All of Hudson County is exposed to the elements of severe weather.

HURRICANES

Tropical systems develop in the Atlantic Ocean or in the warm waters of the Caribbean and Gulf of Mexico. They may move up the Atlantic coast or through the the Gulf Coast states, bringing wind and rain as far north as New England before moving offshore. Figure 11-1 displays tropical cyclones that tracked within 60 nautical miles of Hudson County (an approximate distance from the center of rotation where significant impacts could be felt) between 1861 and 2023.

Figure 11-1. Historical Tropical Storm and Hurricane Tracks 1861 to 2023

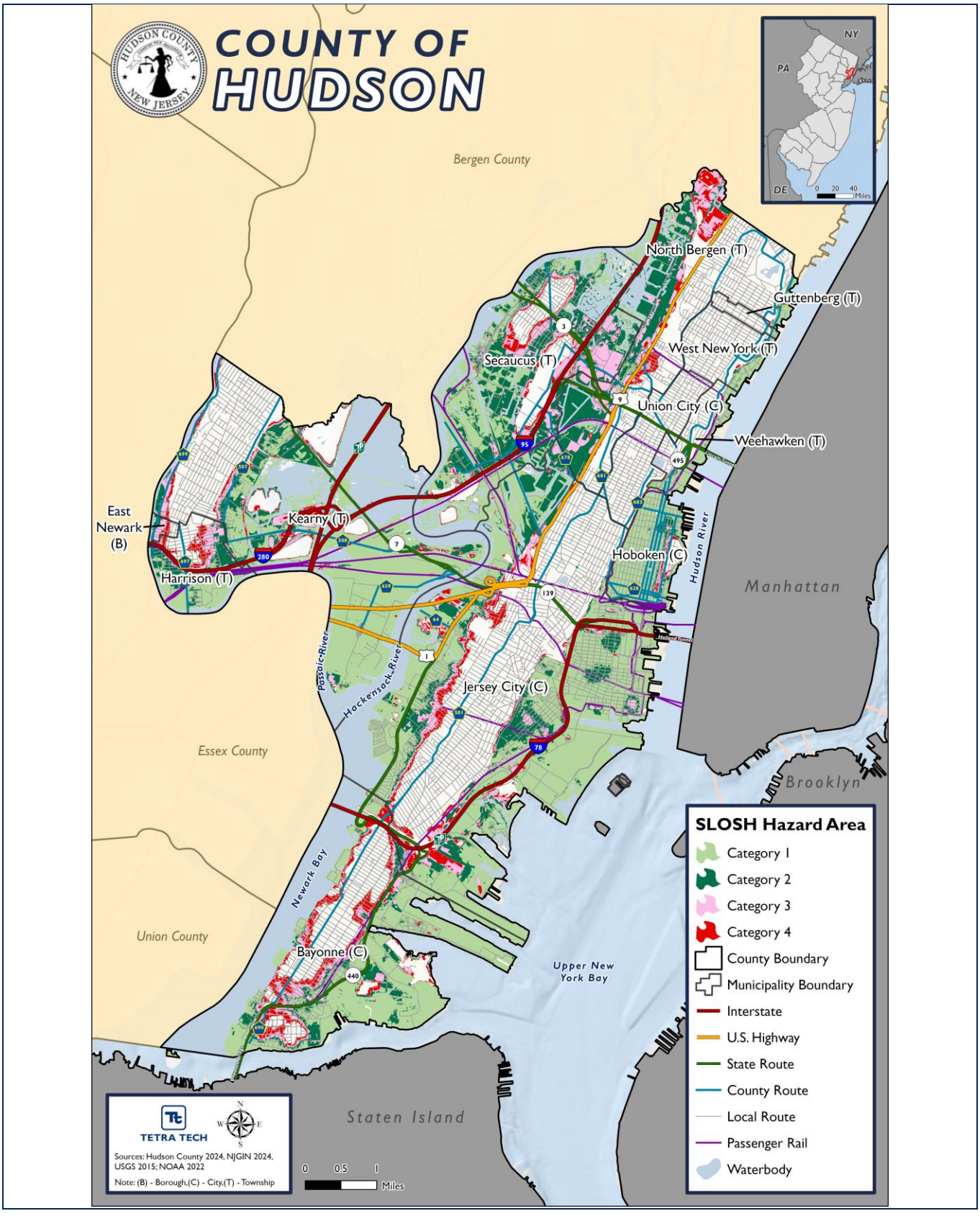


Note: Hudson County is shaded in red.

Source: NOAA 2023

Inundation from hurricane-caused storm surge has devastating impacts on the state's coastal communities. USACE in cooperation with FEMA, initially prepared SLOSH (Sea, Lake, and Overland Surges from Hurricanes) inundation maps (refer to Figure 11-2). SLOSH maps represent potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. The SLOSH maps do not include riverine flooding caused by hurricane surge or inland freshwater flooding. The mapping was developed for the coastal communities in the State of New Jersey using the computer model to forecast surges that occur from wind and pressure forces of hurricanes coastline topography. In the State, hurricane category is the predominant factor in worst-case hurricane surges. The resulting inundation areas are grouped into Category 1 and 2 (dangerous), Category 3 (devastating), and Category 4 (catastrophic) classifications. The hurricane category refers to the Saffir/Simpson Hurricane Intensity Scale.

Figure 11-2. SLOSH Model (Categories 1 to 4) in Hudson County



11.1.3 Extent

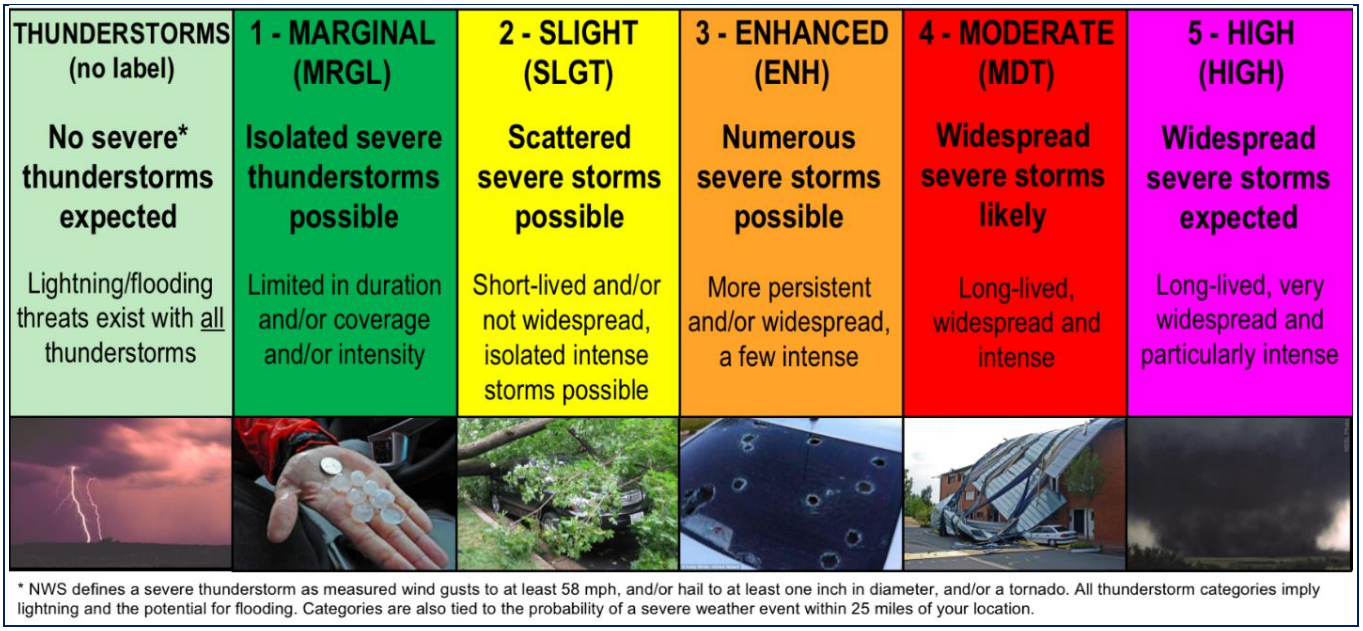
THUNDERSTORMS AND LIGHTNING

Severe thunderstorm statements, watches, and warnings are issued by the local NWS office and the Storm Prediction Center (SPC). The NWS and SPC will update the watches and warnings and notify the public when they are no longer in effect. NWS issues the following statements, watches, and warnings for thunderstorms (NWS 2023):

- A **Special Weather Statement** is issued for strong storms that are below severe levels but may have impacts. It is usually reserved for the threat of wind gust of 40 to 57 mph or hail between a half and one inch in diameter.
- A **Severe Thunderstorm Watches** is issued when severe thunderstorms are possible in and near watch areas.
- A **Severe Thunderstorm Warning** is imminent or occurring that is either detected by weather radar or reported by storm spotters. A severe thunderstorm is one that produces winds 58 mph or stronger or hail that is at least one inch in diameter. A warning means to take shelter.

As depicted in Figure 11-3, the NWS has five categories for severe thunderstorm risk: marginal, slight, enhanced, moderate, and high. The probabilistic forecast expresses the best estimate of a severe weather event occurring within 25 miles of a point (NWS 2019).

Figure 11-3. Thunderstorm Risk



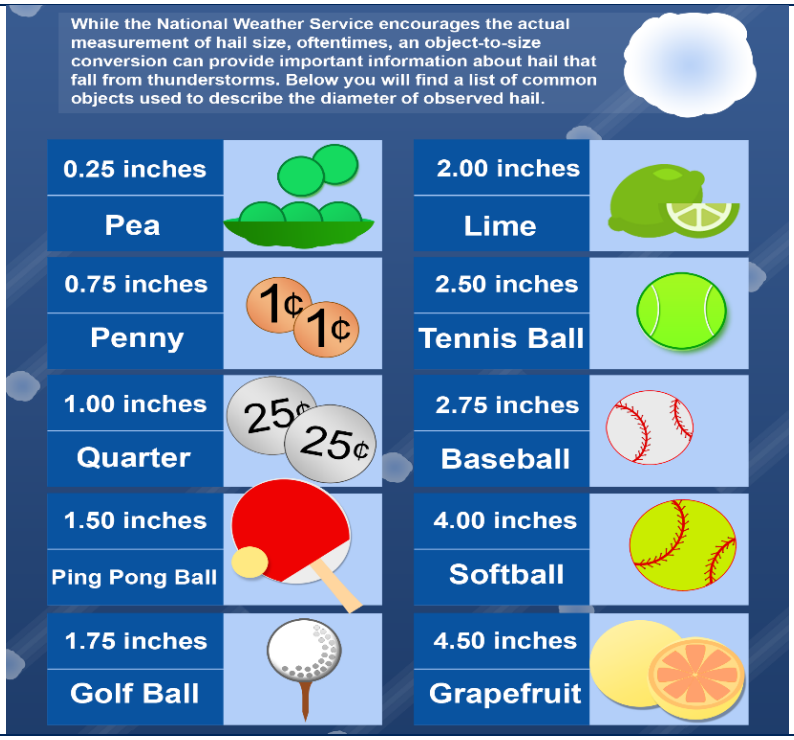
Source: NWS 2019

Currently, cloud-to-ground and intra-cloud lightning flashes are detected and mapped in real-time by two different networks: National Lightning Detection Network and the Earth Networks Total Lightning Network. These systems work by detecting radio atmospheric signals (sferics or spherics) emitted by fast electric currents (strokes) in lightning channels. A stroke can be a fast current within the cloud, or a return stroke in a channel to ground (NOAA n.d.).

HAILSTORMS

The severity of hail is measured by duration, hail size, and geographic extent. Hail can exhibit a variety of sizes, often estimated by comparing the hail to a known object (Figure 11-4). Most hailstorms are made up of a mix of different sizes, and only the very largest hail stones pose serious risk to people caught in the open (NSSL 2021).

Figure 11-4. Hail Size Reference Chart



Source: NWS 2023

HIGH WINDS

Table 11-1 provides the descriptions of wind events and their associated sustained speed used by the NWS. Another scale used to classify wind conditions is the Beaufort wind scale, which is provided in Appendix H (Supplementary Data).

Table 11-1. NWS Wind Descriptions

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

Source: NWS n.d.

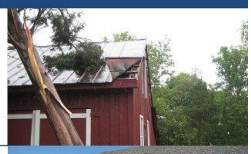
The NWS issues advisories and warnings for winds that are typically site-specific. The NWS issues high wind advisories, watches, and warnings when wind speeds can pose a hazard or are life threatening. The criterion for each of these varies from state to state. Wind warnings and advisories are defined as the following (NWS 2012):

- **Wind Advisories** are issues when sustained winds of 30 to 39 mph are forecast for one hour or longer, or wind gusts of 46 to 57 mph for any duration.
- **High Wind Watches** are issued when there is the possibility that High Wind Warning Criteria may be met at longer ranges (24 to 48 hours out).
- **High Wind Warnings** are issued when sustained wind speeds of 40 mph or greater lasting for one hour or longer or for winds of 58 mph or greater for any duration or widespread damage are possible.

TORNADOES

The magnitude or severity of a tornado is categorized using the Enhanced Fujita (EF) Tornado Intensity Scale. This scale determines tornado ratings by comparing wind speed and actual damage. Figure 11-5 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Figure 11-5 EF Scale Rating Descriptions

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

Source: NWS n.d)

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 2011).

HURRICANES

Hurricane magnitude is measured using the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale rates storms from Categories 1 to 5 (from least to most severe) 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 2023). Table 11-2 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Table 11-2. The Saffir-Simpson Hurricane Scale

Category	Wind Speed (mph)	Expected Damage
1	74 to 95	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 shallow-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 to 110	Extremely dangerous winds will cause extensive damage: Homes with well-constructed frames could sustain major roof and siding damage. Many shallow-rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111 to 129	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 to 156	Catastrophic damage will occur: Homes with well-built frames can sustain severe damage with loss of most of the roof structure and/or 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	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: NOAA 2023

NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of tropical cyclone watches and warnings (NOAA 2023):

- A ***Hurricane 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 cyclone. 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. The warning can remain in effect when

dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.

- A ***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.
- A ***Tropical Storm Warning*** is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.
- A ***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.

Hurricane Winds

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009).

Hurricane return periods are the frequency at which a certain intensity of hurricane can be expected within a given distance of a given location. For example, a return period of 20 years for a major hurricane means that on average during the previous 100 years, a Category 3 or greater hurricane passed within 58 miles of a specific location approximately 5 times. According to the NHC, the return period of hurricanes for Hudson County was not calculated. However, the return period for surrounding counties is 18 to 19 years for a hurricane (greater than 64 mph winds) and 74 to 76 years for a major hurricane (greater than 110 mph winds) (NHC 2020).

Figure 11-6 and Figure 11-7 show the estimated maximum three-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP events. These peak wind speed projections were generated using HAZUS-MH model runs. The estimated hurricane track used for the 100- and 500-year event is also shown. The maximum three-second gust wind speeds for Hudson County is Category 1 hurricane speeds for the 100-year MRP event. The maximum three-second gust wind speeds for Hudson County is Category 2 hurricane speeds for the 500-year MRP event. The associated impacts and losses from these 100-year and 500-year MRP hurricane event model runs are reported in the Vulnerability Assessment.

Storm Surge

Storm surge is estimated by subtracting the regular/astrological tide level from the observed storm tide. Typical storm surge heights range from several feet to more than 25 feet. The exact height of the storm surge and which coastal areas will be flooded depends on many factors: strength, intensity, and speed of the hurricane or storm; the direction it is moving relative to the shoreline; how rapidly the sea floor is sloping along the shore; the shape and elevation of the shoreline; and the astronomical tide. Storm surge is most damaging when it occurs along a shallow sloped shoreline, during high tide, and in a highly populated and developed area.

Typically, storm surge is estimated by subtracting the regular/astrological tide level from the observed storm tide. Storm surge does not include flooding caused by precipitation. Figure 11-8 illustrates water level differences for storm surge, storm tide, and a normal (predicted) high tide as compared to sea level.

Figure 11-6. Wind Speeds for the 100-Year Mean Return Period Event

Figure 11-7. Wind Speeds for the 500-Year Mean Return Period Event

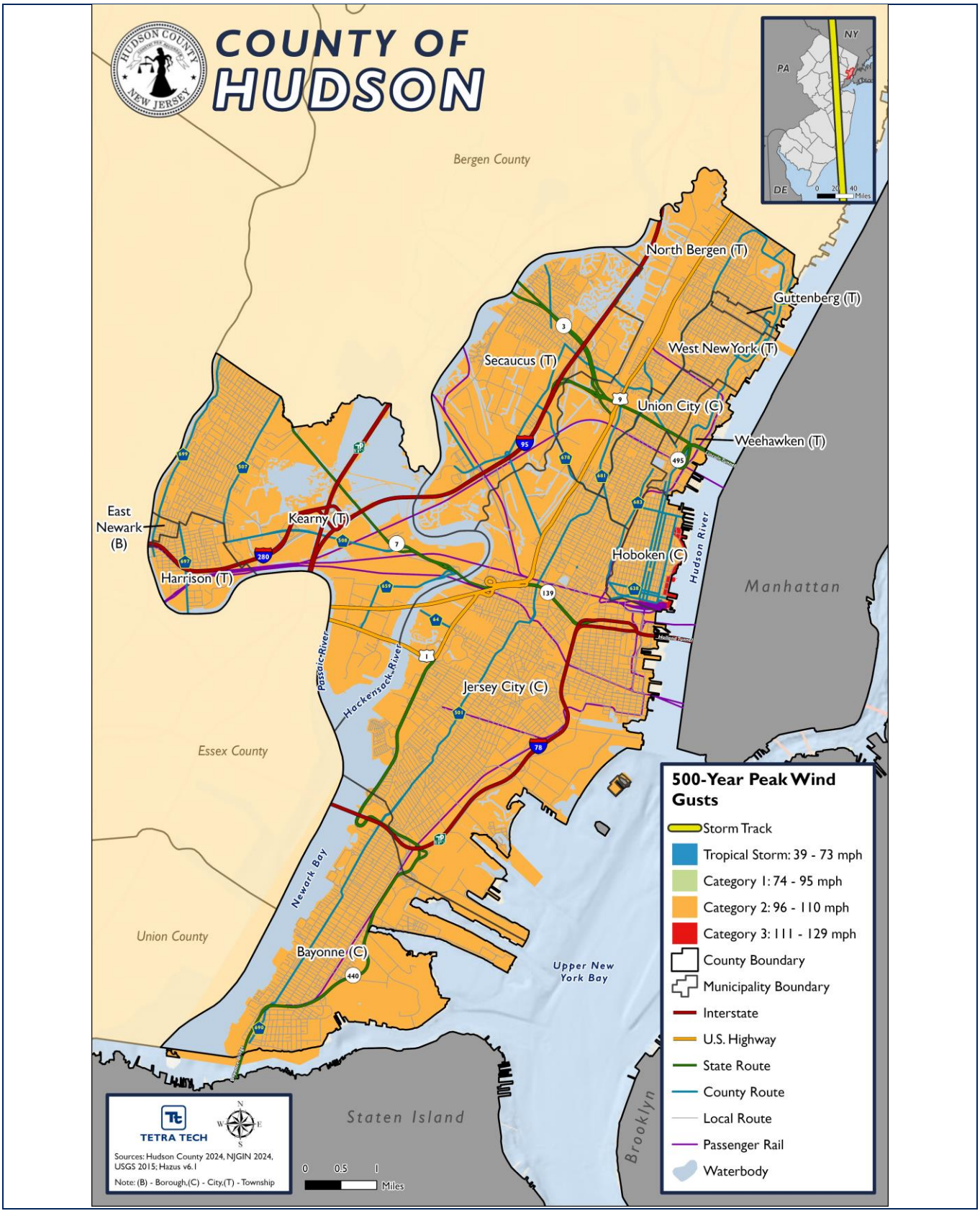
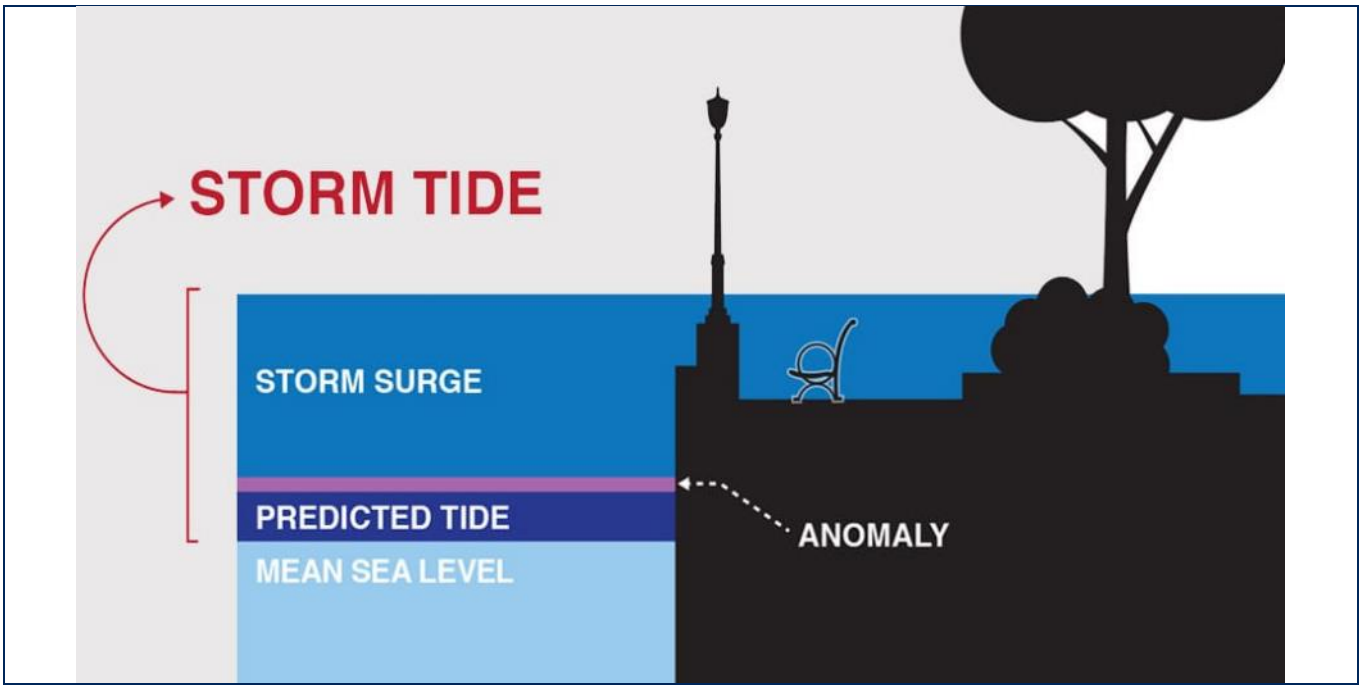


Figure 11-8. Storm Tide Diagram



Source: NOAA 2024

11.1.4 Previous Occurrences

FEMA Major Disaster and Emergency Declarations

Between 1954 and 2023, Hudson County was included in 10 major disaster (DR) or emergency (EM) declarations for severe weather-related events (FEMA 2024). Table 11-3 lists these declarations.

Table 11-3. FEMA Declarations for Severe Weather Events in Hudson County (1954 to 2023)

Event Date	Declaration Date	Declaration Number	Description
August 20, 1955	August 20, 1955	DR-41-NJ	Hurricane & Floods
October 18, 1996	November 19, 1996	DR-1145-NJ	Severe Storms and Flooding
September 16, 1999	September 17, 1999	EM-3148-NJ	Hurricane Floyd
August 29, 2005	September 19, 2005	EM-3257-NJ	Hurricane Katrina Evacuation
April 14, 2007	April 26, 2007	DR-1694-NJ	Severe Storms and Inland/Coastal Flooding
August 26, 2011	August 27, 2011	EM-3332-NJ	Hurricane Irene
August 27, 2011	August 31, 2011	DR-4021-NJ	Hurricane Irene
October 26, 2012	October 28, 2012	EM-3354-NJ	Hurricane Sandy
October 26, 2012	October 30, 2012	DR-4086-NJ	Hurricane Sandy
September 1, 2021	September 2, 2021	EM-3573-NJ	Remnants of Hurricane Ida
September 1, 2021	September 5, 2021	DR-4614-NJ	Remnants of Hurricane Ida

Sources: FEMA 2024

USDA Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in contiguous counties. Between 2019 and 2023, Hudson County has not been included in any USDA Severe Weather-related agricultural disaster declarations.

Previous Events

Known hazard events that impacted Hudson County between August 2019 and December 2023 are discussed in Table 11-4. For events prior to 2019, refer to the 2020 Hudson County HMP.

Table 11-4. Severe Weather Events in Hudson County (2019 to 2023)

Event Date	FEMA or State Declaration Number	Hudson County included in declaration?	Location Impacted	Description
October 31, 2019	N/A	N/A	Communipaw (Jersey City)	An unseasonably humid air mass ahead of a cold front triggered a severe thunderstorm that impacted Northeastern New Jersey. Thunderstorm winds of 60 mph recorded.
February 7, 2020	N/A	N/A	County-wide	Strong winds of 53 mph recorded in Bayonne.
April 13, 2020	N/A	N/A	County-wide	Deep low pressure passed to the west of the area resulting in high winds. Law enforcement reported a tree down on 33rd Street, blocking the road in Union City.
August 4, 2020	N/A	N/A	County-wide	Hurricane Isaias passed through the New York City area on August 4, 2020. Northeastern NJ recorded sustained wind speeds of 35 to 50 mph and gusts of 60 to 70, resulting in widespread wind damage, power outages, and mass transit disruptions.
November 15, 2020	N/A	N/A	Granton Junction (North Bergen), Babbitt (North Bergen), Communipaw (Jersey City)	A strong cold front triggered convective showers and thunderstorms across northeastern New Jersey. In Jersey City, wind gusts of 68 mph were recorded. Winds resulted in downed trees and power outages in North Bergen.
December 25, 2020	N/A	N/A	County-wide	A cold front with high winds ahead of it passed through during the early morning hours. A sustained wind of 42 mph was measured at a mesonet station located in Weehawken. A sustained wind of 40 mph was measured at a mesonet station located in Harrison. Additionally, Law Enforcement reported a partial collapse of the roof, fire escape, and cornice at 1st Street and Willow Avenue in Hoboken. At Robbins Reef lighthouse, a measured sustained wind of 54 mph, and a wind gust of 78 mph. Robbins Reef winds are measured at an elevation of 69 feet.

Event Date	FEMA or State Declaration Number	Hudson County included in declaration?	Location Impacted	Description
January 29, 2021	N/A	N/A	County-wide	High winds occurred over the region as high pressure built in from the west behind a strengthening coastal low-pressure system heading northeast after passing well to the south. A measured sustained wind of 45 mph occurred at nearby Robbins Reef Lighthouse at an elevation of 69 feet above ground.
March 26, 2021	N/A	N/A	County-wide	A low-pressure center moved across the Northeast, dragging a cold front across northeastern New Jersey with high winds. A wind gust of 62 mph occurred at Robbins Reef Lighthouse at an elevation of 69 feet above ground level.
April 30, 2021	N/A	N/A	County-wide	After a cold front passage during the predawn hours, an associated low pressure system strengthened along the New England Coast, tightening the pressure gradient and causing high winds across parts of Northeastern New Jersey. A wind gust of 65 mph occurred at a mesonet station in Jersey City.
September 2, 2021	EM-3573-NJ DR-4614-NJ	Yes	County-wide	Extremely heavy rainfall associated with the remnants of Hurricane Ida resulted in numerous road closures and water rescues throughout the County. Rainfall totals ranged from five to eight inches.
December 6, 2021	N/A	N/A	Greenville	A cold front triggered quasi-convective shower across northeastern New Jersey. Thunderstorm wind gusts of 58 were recorded at Honorable William Wall station near Jersey City.
November 30, 2022	N/A	N/A	County-wide	The pressure gradient tightened as a cold front approached from the west. This produced high winds over Southeastern New Jersey in the late afternoon to early evening hours. A measured wind gust of 60 mph was recorded at a mesonet station located in Jersey City, NJ
December 23, 2022	N/A	N/A	County-wide	A strong low-pressure system centered near the eastern Great Lakes Region continued to strengthen as it moved northeast. his brought high winds over northeastern New Jersey that morning as the pressure gradient tightened over the area. A trained spotter reported a downed tree across Davis Avenue in Harrison, NJ.
February 3, 2023	N/A	N/A	County-wide	An arctic cold front passed through the region during the morning of February 3, 2023. Strong cold air advection along with a tightening pressure gradient produced high winds over Northeastern New Jersey during the late afternoon into early evening hours of this day. A measured wind gust of 62 mph was recorded at a mesonet station located at Robbins Reef, NJ at an elevation of 70 feet.

Sources: FEMA 2024; NOAA NCEI 2024

11.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

Information on previous severe weather occurrences in the county was used to calculate the probability of future occurrence of such events, as summarized in Table 11-5. Based on historical records and input from the Steering Committee, the probability of occurrence for severe weather in the County is considered "occasional."

Table 11-5. Probability of Future Severe Weather Events in Hudson County

Hazard Type	Number of Occurrences Between 1996 and 2023	Percent Chance of Occurring in Any Given Year
Hailstorms	15	54%
Heavy Rain	16	57%
High Winds	33	100%
Lightning	5	18%
Storm Surge	0	0%
Strong Winds	15	54%
Thunderstorm Winds	60	100%
Hurricanes	4	14%
Total	**148**	**100%**

Sources: NOAA NCEI 2024

Notes: Due to limitations in data, not all Severe Weather events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is calculated using the number of occurrences between 1996 and 2023. Hurricanes include tropical storms.

Effect of Climate Change on Future Probability

A warmer atmosphere means storms have the potential to be more intense and occur more often. In the State of New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in the State of New Jersey, storms that resulted in extreme rain increased by 71 percent which is a faster rate than anywhere else in the United States (NJDEP 2020).

11.1.6 Cascading Impacts on Other Hazards

Severe weather may exacerbate flooding and dam failures. As discussed, the heavy precipitation associated with these events can create major flooding issues in the County. Strong winds can be destructive to the functionality of utilities by breaching power lines and disconnecting the utility systems, as well as result in falling trees and branches. Fallen trees and branches increases available fuel for wildfires. For more information on the wildfire hazard, refer to Chapter 13 (Wildfire) for more information about this hazard of concern.

11.2 Vulnerability and Impact Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the hazard area identified. The entire County has been identified as exposed for severe storms. Therefore, all assets in the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Chapter 3), are exposed and vulnerable to severe storm events.

11.2.1 Life, Health, and Safety

The impact of severe weather events on life, health, and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents.

Overall Population

The entire population of Hudson County (724,854) is exposed to this hazard; however, the impact of these events can have on life, health, and safety are dependent upon several factors, including the severity of the event and whether adequate warning time was provided to residents.

Outdoor workers are vulnerable to severe weather events. Employers should prepare for the hazards associated with adverse weather conditions that may require special facilities and safety equipment being provided to employees, or in some instances, work stoppage to ensure the safety and health of workers. Wet weather and high wind conditions can pose a greater threat to employees working in the construction and shipbuilding industries. For instance, workers in the construction industry are bound to work in open spaces, at heights, with electrical equipment and metals, in excavation areas and trenches, and may handle hazardous materials as a work task, thereby causing exposure to a myriad of safety hazards (Hazwoper OSHA 2020).

Storm Surge

Table 11-6 presents the distribution of people residing in different SLOSH category hazard areas across jurisdictions in Hudson County. The City of Hoboken has the highest percentage of its population in all four SLOSH hazard areas, with nearly 99 percent in Category 4. In contrast, the City of Union City has no population in any SLOSH hazard area. The City of Jersey City has the largest number of people at risk in all four SLOSH hazard areas, with 52,480 in Category 1, 70,435 in Category 2, 78,550 in Category 3, and lastly, 91,849 in Category 4. Overall, 30.4 percent of Hudson County's population is in the Category 4 hazard area.

Hurricane and Other High Winds

As a result of a significant hurricane event, residents may be displaced or require temporary to long-term sheltering. The number of people requiring shelter is generally less than the number displaced as some displaced persons use hotels or stay with family or friends following a disaster event. Hazus estimates that there will 95 displaced households and 64 persons seeking short-term shelter from the 100-year MRP event. Further, Hazus estimates that there will be 3,259 households displaced and 2,526 persons seeking short-term sheltering caused by the 500-year MRP event (Table 11-7).

Table 11-6. Population in the SLOSH Hazard Areas

Jurisdiction	Total Population	Population in the Category 1 SLOSH Hazard Area		Population in the Category 2 SLOSH Hazard Area		Population in the Category 3 SLOSH Hazard Area		Population in the Category 4 SLOSH Hazard Area	
		Number of People	Percent Total	Number of People	Percent Total	Number of People	Percent Total	Number of People	Percent Total
Bayonne (C)	71,686	8,574	12.0%	13,467	18.8%	20,576	28.7%	34,175	47.7%
East Newark (B)	2,594	0	0.0%	13	0.5%	589	22.7%	1,435	55.3%
Guttenberg (T)	12,017	709	5.9%	1,002	8.3%	1,383	11.5%	1,846	15.4%
Harrison (T)	19,450	276	1.4%	2,538	13.0%	5,904	30.4%	10,455	53.8%
Hoboken (C)	60,419	51,037	84.5%	57,457	95.1%	58,949	97.6%	59,638	98.7%
Jersey City (C)	292,449	52,480	17.9%	70,435	24.1%	78,550	26.9%	91,849	31.4%
Kearny (T)	41,999	861	2.1%	2,139	5.1%	3,317	7.9%	4,300	10.2%
North Bergen (T)	63,361	160	0.3%	222	0.4%	915	1.4%	2,930	4.6%
Secaucus (T)	22,181	1,190	5.4%	5,727	25.8%	9,264	41.8%	11,895	53.6%
Union City (C)	68,589	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Weehawken (T)	17,197	1,026	6.0%	1,053	6.1%	1,053	6.1%	1,053	6.1%
West New York (T)	52,912	310	0.6%	443	0.8%	457	0.9%	457	0.9%
Hudson County (Total)	**724,854**	**116,623**	**16.1%**	**154,496**	**21.3%**	**180,957**	**25.0%**	**220,033**	**30.4%**

Source: NJOIT, GIS 2024; Microsoft BING 2019; NOAA 2022

Table 11-7. Estimated Displaced Households and Persons Seeking Shelter Caused by the 100- and 500- Year MRP Hurricane Events

Jurisdiction	100-Year MRP Hurricane		500-Year MRP Hurricane	
	Displaced Households	Persons Seeking Short-Term Sheltering	Displaced Households	Persons Seeking Short-Term Sheltering
Bayonne (C)	25	20	363	297
East Newark (B)	0	0	4	5
Guttenberg (T)	0	0	56	51
Harrison (T)	3	2	44	37
Hoboken (C)	13	3	516	194
Jersey City (C)	40	25	1343	787
Kearny (T)	3	3	71	92
North Bergen (T)	1	1	199	284
Secaucus (T)	3	3	57	34
Union City (C)	2	3	285	437
Weehawken (T)	3	2	135	74
West New York (T)	2	2	186	234
Hudson County (Total)	**95**	**64**	**3,259**	**2,526**

Source: Hazus v6.1, U.S. Census Bureau 2020

SOCIALLY VULNERABLE POPULATION

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors, including their physical and financial ability to react or respond during a hazard. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations may be more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over the age of 65 is more vulnerable because they are more likely to need medical attention, which may not be available due to isolation during a flood event, and they may have more difficulty evacuating.

Table 11-8 through Table 11-11 highlight the distribution of socially vulnerable populations residing in different SLOSH hazard categories. In the Category 1 SLOSH hazard area, the City of Jersey City has the highest number of vulnerable individuals, to include 5,862 persons over the age of 65, 3,674 persons under the age of 5 years, 5,216 non-English speakers, 4,018 persons with a disability, and 7,740 persons living in poverty. The Borough of East Newark and The City of Union City have no vulnerable populations in this category. The City of Jersey City leads again for the highest number of vulnerable persons located in the Category 2 hazard area, with 7,868 persons over the age of 65, 4,931 persons under the age of 5 years, 7,001 non-English speakers, 5,394 persons with a disability, and 10,388 persons living in poverty. The City of Union City has no vulnerable populations in this category. The City of Jersey City also leads in the highest number of vulnerable populations for Category 3 and Category 4 SLOSH hazard areas.

Table 11-8. Estimated Vulnerable Person Located in the Category 1 SLOSH Hazard Area

Jurisdiction	Estimated Number of Vulnerable Persons Located in the Category 1 SLOSH Hazard Area									
	Over 65	Percent of Jurisdiction Total	Under 5	Percent of Jurisdiction Total	Non-English Speaking	Percent of Jurisdiction Total	Disability	Percent of Jurisdiction Total	Poverty Level	Percent of Jurisdiction Total
Bayonne (C)	1,191	12.0%	611	12.0%	676	11.9%	820	12.0%	1,006	12.0%
East Newark (B)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Guttenberg (T)	95	5.9%	47	5.8%	119	5.9%	78	5.8%	110	5.9%
Harrison (T)	29	1.4%	16	1.4%	58	1.4%	20	1.4%	38	1.4%
Hoboken (C)	3,259	84.5%	3,463	84.5%	2,206	84.4%	2,597	84.5%	3,810	84.5%
Jersey City (C)	5,862	17.9%	3,674	17.9%	5,216	17.9%	4,018	17.9%	7,740	17.9%
Kearny (T)	112	2.0%	55	2.0%	115	2.0%	65	2.0%	87	2.0%
North Bergen (T)	26	0.2%	9	0.2%	27	0.2%	15	0.2%	18	0.2%
Secaucus (T)	179	5.3%	56	5.3%	115	5.3%	104	5.3%	60	5.3%
Union City (C)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Weehawken (T)	122	6.0%	59	5.9%	75	5.9%	63	5.9%	74	5.9%
West New York (T)	39	0.6%	13	0.5%	75	0.6%	34	0.6%	62	0.6%
Hudson County (Total)	**10,914**	**12.6%**	**8,003**	**17.1%**	**8,682**	**9.3%**	**7,814**	**12.8%**	**13,005**	**13.1%**

Source: US Census Bureau, ACS 5-Year Estimates; NOAA 2022

Table 11-9. Estimated Vulnerable Person Located in the Category 2 SLOSH Hazard Area

Jurisdiction	Estimated Number of Vulnerable Persons Located in the Category 2 SLOSH Hazard Area									
	Over 65	Percent of Jurisdiction Total	Under 5	Percent of Jurisdiction Total	Non-English Speaking	Percent of Jurisdiction Total	Disability	Percent of Jurisdiction Total	Poverty Level	Percent of Jurisdiction Total
Bayonne (C)	1,871	18.8%	959	18.8%	1,063	18.8%	1,288	18.8%	1,581	18.8%
East Newark (B)	1	0.3%	0	0.0%	2	0.4%	1	0.5%	3	0.5%
Guttenberg (T)	135	8.3%	67	8.3%	168	8.3%	111	8.3%	156	8.3%
Harrison (T)	269	13.0%	154	13.0%	534	13.0%	188	13.0%	354	13.0%
Hoboken (C)	3,669	95.1%	3,899	95.1%	2,483	95.1%	2,924	95.1%	4,289	95.1%
Jersey City (C)	7,868	24.1%	4,931	24.1%	7,001	24.1%	5,394	24.1%	10,388	24.1%
Kearny (T)	278	5.1%	137	5.1%	286	5.1%	162	5.1%	217	5.1%
North Bergen (T)	36	0.3%	13	0.3%	38	0.3%	21	0.3%	25	0.3%
Secaucus (T)	866	25.8%	272	25.8%	555	25.8%	503	25.8%	289	25.8%
Union City (C)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Weehawken (T)	125	6.1%	61	6.1%	77	6.1%	65	6.1%	76	6.1%
West New York (T)	55	0.8%	19	0.8%	108	0.8%	48	0.8%	89	0.8%
Hudson County (Total)	**15,173**	**17.5%**	**10,512**	**22.4%**	**12,315**	**13.2%**	**10,705**	**17.5%**	**17,467**	**17.5%**

Source: US Census Bureau, ACS 5-Year Estimates; NOAA 2022

Table 11-10. Estimated Vulnerable Person Located in the Category 3 SLOSH Hazard Area

Jurisdiction	Estimated Number of Vulnerable Persons Located in the Category 3 SLOSH Hazard Area									
	Over 65	Percent of Jurisdiction Total	Under 5	Percent of Jurisdiction Total	Non-English Speaking	Percent of Jurisdiction Total	Disability	Percent of Jurisdiction Total	Poverty Level	Percent of Jurisdiction Total
Bayonne (C)	2,859	28.7%	1,466	28.7%	1,624	28.7%	1,969	28.7%	2,416	28.7%
East Newark (B)	69	22.4%	24	22.6%	107	22.6%	47	22.5%	144	22.6%
Guttenberg (T)	186	11.5%	93	11.5%	232	11.5%	153	11.4%	215	11.5%
Harrison (T)	626	30.3%	359	30.3%	1,243	30.3%	438	30.3%	825	30.4%
Hoboken (C)	3,765	97.6%	4,000	97.6%	2,548	97.5%	3,000	97.6%	4,401	97.6%
Jersey City (C)	8,775	26.9%	5,499	26.9%	7,808	26.9%	6,015	26.9%	11,585	26.9%
Kearny (T)	432	7.9%	213	7.9%	444	7.9%	252	7.9%	336	7.9%
North Bergen (T)	151	1.4%	55	1.4%	158	1.4%	88	1.4%	106	1.4%
Secaucus (T)	1,400	41.7%	441	41.8%	898	41.8%	814	41.7%	468	41.7%
Union City (C)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Weehawken (T)	125	6.1%	61	6.1%	77	6.1%	65	6.1%	76	6.1%
West New York (T)	57	0.9%	20	0.8%	112	0.9%	50	0.9%	92	0.9%
Hudson County (Total)	**18,445**	**21.3%**	**12,231**	**26.1%**	**15,251**	**16.3%**	**12,891**	**21.1%**	**20,664**	**20.8%**

Source: US Census Bureau, ACS 5-Year Estimates; NOAA 2022

Table 11-11. Estimated Vulnerable Person Located in the Category 4 SLOSH Hazard Area

Jurisdiction	Estimated Number of Vulnerable Persons Located in the Category 4 SLOSH Hazard Area									
	Over 65	Percent of Jurisdiction Total	Under 5	Percent of Jurisdiction Total	Non-English Speaking	Percent of Jurisdiction Total	Disability	Percent of Jurisdiction Total	Poverty Level	Percent of Jurisdiction Total
Bayonne (C)	4,749	47.7%	2,435	47.7%	2,697	47.7%	3,270	47.7%	4,012	47.7%
East Newark (B)	170	55.2%	58	54.7%	262	55.3%	115	55.0%	353	55.3%
Guttenberg (T)	248	15.3%	124	15.3%	309	15.3%	205	15.3%	288	15.4%
Harrison (T)	1,109	53.7%	635	53.7%	2,202	53.7%	776	53.7%	1,461	53.8%
Hoboken (C)	3,809	98.7%	4,047	98.7%	2,578	98.7%	3,035	98.7%	4,452	98.7%
Jersey City (C)	10,260	31.4%	6,430	31.4%	9,130	31.4%	7,033	31.4%	13,547	31.4%
Kearny (T)	559	10.2%	276	10.2%	575	10.2%	327	10.2%	436	10.2%
North Bergen (T)	485	4.6%	177	4.6%	506	4.6%	283	4.6%	339	4.6%
Secaucus (T)	1,798	53.6%	566	53.6%	1,153	53.6%	1,046	53.6%	601	53.6%
Union City (C)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Weehawken (T)	125	6.1%	61	6.1%	77	6.1%	65	6.1%	76	6.1%
West New York (T)	57	0.9%	20	0.8%	112	0.9%	50	0.9%	92	0.9%
Hudson County (Total)	**23,369**	**27.0%**	**14,829**	**31.7%**	**19,601**	**21.0%**	**16,205**	**26.5%**	**25,657**	**25.8%**

Source: US Census Bureau, ACS 5-Year Estimates; NOAA 2022

11.2.2 General Building Stock

All buildings are exposed to severe weather hazards such as hailstorms and lightning strikes. While hailstorms are not frequently known to cause major injuries or damage in New Jersey, an extreme event can carry hail stones at speeds greater than 100 miles per hour (National Weather Service 2019). This could cause structural damage for the general building stock in the County. Severe summer weather that causes lightning could be a threat to the County's general building stock if the lightning starts a fire. Over 22,000 fires caused by lightning occurred annually throughout the U.S. between 2007 and 2011, which was valued at approximately $450 million of damages per year (National Fire Protection Association 2013).

Storm Surge

Understanding the distribution of buildings in SLOSH hazard areas is crucial for assessing potential risks and economic impacts in Hudson County. Table 11-12 and Table 11-13 provides an overview of the number and replacement cost value of buildings located in the SLOSH hazard areas across various jurisdictions within the county. The City of Hoboken has the highest number of buildings in all four SLOSH hazard areas, with 11,843 buildings in Category 1, 13,370 in Category 2, 13,839 buildings in Category 3, and 14,064 in Category 4. However, the City of Jersey City leads with the highest replacement cost values in each category; S11 billion in Category 1, $15 billion in Category 2, $16 billion in Category 3, and $ 17 billion in Category 4. The replacement cost value of these buildings is significant, highlighting the potential economic impact of storm surges.

Hudson County has a significant number of buildings located in SLOSH hazard areas, highlighting the potential risk from storm surges. In the Category 1 hazard area, there are 18,592 residential buildings, 1,225 commercial buildings, 1,597 industrial buildings, and 890 buildings classified as "other," which include government, religious, agricultural, and educational structures. These numbers increase in Category 2 to 23,720 residential buildings, 1,802 commercial buildings, 1,995 industrial buildings, and 1,182 other buildings. Category 3 sees further increases, with 27,004 residential buildings, 2,229 commercial buildings, 2,127 industrial buildings, and 1,337 other buildings. Finally, in Category 4, there are 31,515 residential buildings, 2,604 commercial buildings, 2,217 industrial buildings, and 1,526 other buildings.

Table 11-14 and Table 11-15 provide a breakdown of these numbers by jurisdiction, offering insights into the distribution of buildings at risk across different areas within Hudson County.

Hurricane and Other High Winds

For hurricane and other high wind events, building construction plays a major role in the extent of damage. Residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings tend to experience more damage than concrete or steel buildings. High-rise buildings are very vulnerable structures. Mobile homes are the most vulnerable to damage, even if tied down. The Hazus hurricane wind model was run to estimate potential losses to buildings. Expected building damage was evaluated across the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 11-16 summarizes the definition of the damage categories.

Table 11-12.Buildings in the Category 1 and 2 SLOSH Hazard Area

Jurisdiction	Jurisdiction Total Buildings		Buildings in Category 1 SLOSH Hazard Area				Buildings in Category 2 SLOSH Hazard Area			
			Number of Buildings		Replacement Cost Value		Number of Buildings		Replacement Cost Value	
	Count	Replacement Cost Value	Count	% of Jurisdiction Total	Value	% of Jurisdiction Total	Count	% of Jurisdiction Total	Value	% of Jurisdiction Total
Bayonne (C)	9,264	$11,278,964,959	1,877	20.3%	$4,222,041,098	37.4%	2,561	27.6%	$5,395,068,249	47.8%
East Newark (B)	434	$300,712,303	1	0.2%	$1,601,769	0.5%	11	2.5%	$47,665,867	15.9%
Guttenberg (T)	2,574	$1,062,772,505	150	5.8%	$92,528,397	8.7%	207	8.0%	$113,751,115	10.7%
Harrison (T)	2,646	$2,812,269,922	91	3.4%	$1,087,074,231	38.7%	414	15.6%	$1,732,792,311	61.6%
Hoboken (C)	14,289	$6,922,849,652	11,843	82.9%	$5,838,382,906	84.3%	13,370	93.6%	$6,346,248,021	91.7%
Jersey City (C)	38,336	$29,829,276,781	7,252	18.9%	$11,474,465,546	38.5%	9,755	25.4%	$14,876,225,158	49.9%
Kearny (T)	7,207	$9,630,626,567	551	7.6%	$5,313,922,062	55.2%	855	11.9%	$6,190,109,947	64.3%
North Bergen (T)	6,002	$9,906,706,329	71	1.2%	$561,623,503	5.7%	153	2.5%	$2,797,013,276	28.2%
Secaucus (T)	3,844	$12,075,088,549	267	6.9%	$3,040,659,861	25.2%	1,153	30.0%	$8,182,403,520	67.8%
Union City (C)	1,729	$4,009,712,429	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Weehawken (T)	2,112	$1,638,112,105	170	8.0%	$509,711,071	31.1%	174	8.2%	$587,120,098	35.8%
West New York (T)	4,594	$3,076,856,343	31	0.7%	$243,770,001	7.9%	46	1.0%	$277,053,042	9.0%
Hudson County (Total)	**93,031**	**$92,543,948,444**	**22,304**	**24.0%**	**$32,385,780,444**	**35.0%**	**28,699**	**30.8%**	**$46,545,450,604**	**50.3%**

Source: NJOIT, GIS 2024; Microsoft BING 2019; RS Means 2024; NOAA 2022

Table 11-13.Buildings in the Category 3 and 4 SLOSH Hazard Area

Jurisdiction	Jurisdiction Total Buildings		Buildings in Category 3 SLOSH Hazard Area				Buildings in Category 4 SLOSH Hazard Area			
			Number of Buildings		Replacement Cost Value		Number of Buildings		Replacement Cost Value	
	Count	Replacement Cost Value	Count	% of Jurisdiction Total	Value	% of Jurisdiction Total	Count	% of Jurisdiction Total	Value	% of Jurisdiction Total
Bayonne (C)	9,264	$11,278,964,959	3,404	36.7%	$6,397,556,411	56.7%	4,975	53.7%	$7,765,048,711	68.8%
East Newark (B)	434	$300,712,303	112	25.8%	$187,129,871	62.2%	252	58.1%	$235,969,989	78.5%
Guttenberg (T)	2,574	$1,062,772,505	281	10.9%	$136,640,484	12.9%	371	14.4%	$169,927,275	16.0%
Harrison (T)	2,646	$2,812,269,922	847	32.0%	$1,982,782,174	70.5%	1,434	54.2%	$2,281,013,461	81.1%
Hoboken (C)	14,289	$6,922,849,652	13,839	96.9%	$6,555,445,768	94.7%	14,064	98.4%	$6,674,645,372	96.4%
Jersey City (C)	38,336	$29,829,276,781	10,818	28.2%	$15,986,330,951	53.6%	12,498	32.6%	$17,033,306,753	57.1%
Kearny (T)	7,207	$9,630,626,567	1,065	14.8%	$6,362,369,050	66.1%	1,234	17.1%	$6,506,189,027	67.6%
North Bergen (T)	6,002	$9,906,706,329	300	5.0%	$3,912,288,917	39.5%	591	9.8%	$5,026,660,826	50.7%
Secaucus (T)	3,844	$12,075,088,549	1,808	47.0%	$9,997,760,391	82.8%	2,219	57.7%	$10,285,056,179	85.2%
Union City (C)	1,729	$4,009,712,429	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Weehawken (T)	2,112	$1,638,112,105	176	8.3%	$588,949,188	36.0%	177	8.4%	$591,520,181	36.1%
West New York (T)	4,594	$3,076,856,343	47	1.0%	$296,750,758	9.6%	47	1.0%	$296,750,758	9.6%
Hudson County (Total)	**93,031**	**$92,543,948,444**	**32,697**	**35.1%**	**$52,404,003,963**	**56.6%**	**37,862**	**40.7%**	**$56,866,088,532**	**61.4%**

Source: NJOIT, GIS 2024; Microsoft BING 2019; RS Means 2024; NOAA 2022

Table 11-14. Buildings in the SLOSH Categories 1 and 2 Hazard Area by General Occupancy Class

Jurisdiction	Category 1 SLOSH Hazard Area				Category 2 SLOSH Hazard Area			
	Residential	Commercial	Industrial	Other[a]	Residential	Commercial	Industrial	Other[a]
Bayonne (C)	913	61	823	80	1,434	101	923	103
East Newark (B)	0	0	1	0	2	0	9	0
Guttenberg (T)	138	0	0	12	195	0	0	12
Harrison (T)	31	8	37	15	285	40	54	35
Hoboken (C)	11,185	430	27	201	12,592	533	27	218
Jersey City (C)	5,872	636	320	424	7,881	908	418	548
Kearny (T)	128	22	319	82	318	61	364	112
North Bergen (T)	13	30	11	17	18	41	62	32
Secaucus (T)	176	14	49	28	847	94	127	85
Union City (C)	0	0	0	0	0	0	0	0
Weehawken (T)	115	20	10	25	118	20	11	25
West New York (T)	21	4	0	6	30	4	0	12
Hudson County (Total)	**18,592**	**1,225**	**1,597**	**890**	**23,720**	**1,802**	**1,995**	**1,182**

Source: NJOIT, GIS 2024; Microsoft BING 2019; RS Means 2024; NOAA 2022

a. Other = Government, Religion, Agricultural, and Education buildings

Table 11-15. Buildings in the SLOSH Categories 3 and 4 Hazard Area by General Occupancy Class

Jurisdiction	Category 3 SLOSH Hazard Area				Category 4 SLOSH Hazard Area			
	Residential	Commercial	Industrial	Other[a]	Residential	Commercial	Industrial	Other[a]
Bayonne (C)	2,191	150	932	131	3,639	222	949	165
East Newark (B)	87	4	19	2	212	16	19	5
Guttenberg (T)	269	0	0	12	359	0	0	12
Harrison (T)	663	69	64	51	1,174	125	67	68
Hoboken (C)	12,919	666	27	227	13,070	734	27	233
Jersey City (C)	8,789	987	460	582	10,277	1,069	499	653
Kearny (T)	493	78	367	127	639	92	367	136
North Bergen (T)	74	74	96	56	237	135	121	98
Secaucus (T)	1,370	177	149	112	1,759	187	155	118
Union City (C)	0	0	0	0	0	0	0	0
Weehawken (T)	118	20	13	25	118	20	13	26
West New York (T)	31	4	0	12	31	4	0	12
Hudson County (Total)	**27,004**	**2,229**	**2,127**	**1,337**	**31,515**	**2,604**	**2,217**	**1,526**

Source: NJOIT, GIS 2024; Microsoft BING 2019; RS Means 2024; NOAA 2022

a. Other = Government, Religion, Agricultural, and Education buildings

Table 11-16. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof cover, with no or very limited water penetration.	≤2%	No	No	No	No	No
Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.	>2% and ≤15%	One window, door, or garage door failure	No	<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%	> one and ≤ the larger of 20% & 3	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%	> the larger of 20% & 3 and ≤50%	>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 2022

Building damage as a result of the 100-year and 500-year MRP hurricane wind events were estimated using Hazus, as summarized in Table 11-17. Fourteen residential buildings will be completely destroyed by the 100-year MRP event, and seven residential, five commercial, and one industrial building will be severely damaged. For the 500-year MRP event, most of the losses are estimated to be within the residential occupancy class. Up to 1,014 residential buildings will be completely destroyed and 399 residential buildings will experience severe damages. Furthermore, 4,405 will be moderately damaged and 19,239 will have minor damages.

Table 11-18 summarizes the replacement cost value damage estimated for the 100- and 500-year MRP wind-only events. The total estimated damage to buildings for all occupancy types across Hudson County is estimated to be approximately $6 million and $65 million for the 100- and 500-year MRP events. Most of these losses are to residential buildings. Due to differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. The damage counts include buildings damaged at all severity levels from minor damage to destruction. Total dollar damage reflects the overall impact to buildings at an aggregate level. The City of Jersey City is estimated to experience the greatest damage in a 100-and 500-year MRP event, approximately $3 million and $32 million. Damages to buildings is a direct result of wind speeds, direction, and duration, which is dependent upon the storm's intensity and track.

Table 11-17. Expected Damage from the 100- and 500-Year MRP Events

Total Number of Buildings in Occupancy	Severity of Expected Damage	100-Year Mean Return Period		500-Year Mean Return Period	
		Building Count	% Buildings in Occupancy Class	Building Count	% Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)					
79,906	NONE	74,515	93.3%	54,848	68.6%
	MINOR	5,022	6.3%	19,239	24.1%
	MODERATE	348	0.4%	4,405	5.5%
	SEVERE	7	<0.1%	399	0.5%
	DESTRUCTION	14	<0.1%	1,014	1.3%
Commercial Buildings					
7,174	NONE	6,619	92.3%	4,804	67.0%
	MINOR	399	5.6%	1,239	17.3%
	MODERATE	151	2.1%	1,015	14.2%
	SEVERE	5	0.1%	115	1.6%
	DESTRUCTION	0	0.0%	0	0.0%
Industrial Buildings					
2,746	NONE	2,604	94.8%	1,997	72.7%
	MINOR	126	4.6%	480	17.5%
	MODERATE	15	0.5%	237	8.6%
	SEVERE	1	<0.1%	33	1.2%
	DESTRUCTION	0	0.0%	0	0.0%
Other Buildings[a]					
3,204	NONE	3,063	95.6%	2,406	75.1%
	MINOR	124	3.9%	526	16.4%
	MODERATE	17	0.5%	245	7.6%
	SEVERE	0	0.0%	28	0.9%
	DESTRUCTION	0	0.0%	0	0.0%

Source: Hazus v6.1; NJOIT 2024; Microsoft BING 2019

a. "Other" occupancy classes include Government, Religion, Agricultural, and Education Buildings

Table 11-18. Estimated Building Damage by General Occupancy by the 100- and 500-Year MRP Events

Jurisdiction	Estimated Building Losses (Residential)		Estimated Building Losses (Commercial)		Estimated Building Losses (Industrial)		Estimated Damages (All Other Occupancies)		Estimated Building Losses (All Occupancies)	
	100-Year MRP Event	500-Year MRP Event	100-Year MRP Event	500-Year MRP Event	100-Year MRP Event	500-Year MRP Event	100-Year MRP Event	500-Year MRP Event	100-Year MRP Event	500-Year MRP Event
Bayonne (C)	$20,021,151	$110,239,810	$2,753,811	$14,239,300	$1,819,939	$16,751,806	$1,077,729	$7,688,761	$25,672,630	$148,919,677
East Newark (B)	$461,740	$1,735,376	$23,053	$81,793	$44,507	$261,481	$14,108	$65,964	$543,407	$2,144,614
Guttenberg (T)	$2,066,130	$20,368,030	$75,038	$652,985	$12,116	$221,088	$29,677	$500,022	$2,182,961	$21,742,125
Harrison (T)	$3,899,895	$15,235,112	$318,137	$1,200,470	$320,272	$2,088,307	$315,128	$1,595,318	$4,853,432	$20,119,207
Hoboken (C)	$15,969,311	$150,855,257	$1,163,530	$9,126,772	$276,164	$3,916,206	$516,793	$7,501,487	$17,925,798	$171,399,722
Jersey City (C)	$33,509,837	$212,348,508	$5,433,894	$34,729,460	$1,776,882	$24,512,719	$3,263,414	$32,435,485	$43,984,027	$304,026,172
Kearny (T)	$8,710,108	$35,196,712	$930,520	$3,581,018	$1,395,547	$13,160,112	$565,003	$3,628,253	$11,601,177	$55,566,096
North Bergen (T)	$7,834,814	$59,877,860	$1,786,879	$13,111,892	$667,155	$10,335,475	$221,056	$2,796,207	$10,509,905	$86,121,434
Secaucus (T)	$5,191,138	$29,777,110	$2,194,157	$12,145,899	$1,786,011	$19,748,108	$236,696	$2,243,563	$9,408,002	$63,914,680
Union City (C)	$5,526,504	$41,572,040	$891,232	$7,087,577	$45,182	$814,008	$280,876	$3,449,418	$6,743,793	$52,923,043
Weehawken (T)	$2,725,699	$25,753,810	$375,649	$3,583,729	$79,867	$1,214,398	$68,722	$1,086,576	$3,249,936	$31,638,513
West New York (T)	$3,181,753	$25,869,150	$508,728	$4,214,040	$46,495	$808,295	$159,292	$2,278,855	$3,896,268	$33,170,341
Hudson County (Total)	**$109,098,080**	**$728,828,775**	**$16,454,628**	**$103,754,935**	**$8,270,138**	**$93,832,003**	**$6,748,492**	**$65,269,911**	**$140,571,337**	**$991,685,623**

Source: Hazus v6.1; NJOIT 2024; Microsoft BING 2019; RS Means 2024

11.2.3 Community Lifelines and Other Critical Facilities

Critical facilities are at risk of being impacted by high winds associated with structural damage, or falling tree limbs/flying debris, which can result in the loss of power. Power loss can greatly impact households, business operations, public utilities, and emergency personnel. Emergency personnel such as police, fire, and EMS will not be able to effectively respond in a power loss event to maintain the safety of its citizens unless backup power and fuel sources are available. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its citizens.

Storm Surge

Community lifelines are essential services that enable the continuous operation of critical government and business functions and are crucial to human health and safety or economic security. In SLOSH hazard areas, these lifelines are particularly vulnerable to disruption. Table 11-19 through Table 11-22 provide detailed information on the distribution and risk levels of various community lifelines within different SLOSH hazard categories across Hudson County. Overall, Hudson County has 391 facilities located in Category 1 SLOSH hazard areas, representing 31.6 percent of the jurisdiction's total. In Category 2, there are 499 facilities (40.3 percent), in Category 3, there are 563 facilities (45.4 percent), and in Category 4, there are 628 facilities (50.7 percent). The Transportation lifeline has the highest number of facilities in all SLOSH Hazard categories; Category 1 (98), Category 2 (127), Category 3 (155) and Category 4 (179). Refer to Section 3 (County Profile) for more information about the critical facilities and lifelines in Hudson County.

Hurricane and Other High Winds

Table 11-23 and Table 11-24 summarize the damage state probabilities for critical facilities during the 100-year and 500-year MRP events.

In the event of a 100-year MRP event, the Safety and Security sector is expected to face the most significant impact, with a loss of 300 days. This sector also has the highest probabilities of damage, with a 7.8 percent chance of minor damage and a 9.1 percent chance of moderate damage. Severe and complete damage probabilities are much lower, at 0.2 percent and less than 0.1 percent. The Hazardous Materials sector also shows notable probabilities of damage, with a 5.5 percent chance of minor damage and a 2.0 percent chance of moderate damage. Severe damage is expected at 0.5 percent, and complete damage is less than 0.1 percent.

In the event of a 500-year MRP event, the Transportation and Energy sectors are expected to sustain the most significant damage. The Transportation sector has the highest probabilities, with an 18.3 percent chance of minor damage, 10.1 percent chance of moderate damage, and 1.5 percent chance of severe damage, with no expected complete damage. The Energy sector follows closely, with a 17.9 percent chance of minor damage, 9.2 percent chance of moderate damage, and 1.2 percent chance of severe damage, also with no expected complete damage. Additionally, the Safety and Security sector is notable for its significant loss of 300 days, despite having lower probabilities of damage.

Table 11-19. Number of Facilities in Category 1 SLOSH Hazard Area, by Lifeline Category

Jurisdiction	Number of Facilities in Category 1 SLOSH Hazard Area, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Jurisdiction Total
Bayonne (C)	0	10	0	3	0	4	9	8	3	37	31.9%
East Newark (B)	0	0	0	0	0	0	0	0	0	0	0.0%
Guttenberg (T)	0	0	0	0	0	0	0	0	0	0	0.0%
Harrison (T)	1	2	0	1	0	1	0	0	1	6	13.3%
Hoboken (C)	1	3	26	5	7	23	9	4	37	115	82.1%
Jersey City (C)	1	15	4	19	3	30	51	11	19	153	35.3%
Kearny (T)	0	10	0	7	0	4	16	7	0	44	41.1%
North Bergen (T)	0	1	0	0	2	0	1	2	2	8	8.0%
Secaucus (T)	2	0	0	2	2	0	4	2	0	12	14.3%
Union City (C)	0	0	0	0	0	0	1	0	0	1	1.1%
Weehawken (T)	0	0	1	0	0	1	7	3	2	14	30.4%
West New York (T)	0	0	0	0	0	0	0	1	0	1	2.1%
Hudson County (Total)	**5**	**41**	**31**	**37**	**14**	**63**	**98**	**38**	**64**	**391**	**31.6%**

Source: Hudson County 2024; HIFLD 2024; NJGIN 2024; NOAA 2022

Table 11-20. Number of Facilities in Category 2 SLOSH Hazard Area, by Lifeline Category

Jurisdiction	Number of Facilities in Category 2 SLOSH Hazard Area, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Jurisdiction Total
Bayonne (C)	0	10	0	6	0	5	13	10	3	47	40.5%
East Newark (B)	0	0	0	0	0	0	1	0	0	1	11.1%
Guttenberg (T)	0	0	0	0	0	0	0	0	0	0	0.0%
Harrison (T)	1	2	0	2	0	2	1	1	2	11	24.4%
Hoboken (C)	1	3	26	5	8	24	9	6	43	125	89.3%
Jersey City (C)	1	18	5	20	3	45	56	12	27	187	43.1%
Kearny (T)	0	10	0	7	0	5	20	10	0	52	48.6%
North Bergen (T)	0	3	0	1	2	0	3	4	2	15	15.0%
Secaucus (T)	4	3	0	2	3	5	15	6	4	42	50.0%
Union City (C)	0	0	0	0	0	0	1	0	0	1	1.1%
Weehawken (T)	0	0	1	0	0	1	8	3	2	15	32.6%
West New York (T)	0	0	0	0	0	1	0	2	0	3	6.3%
Hudson County (Total)	**7**	**49**	**32**	**43**	**16**	**88**	**127**	**54**	**83**	**499**	**40.3%**

Source: Hudson County 2024; HIFLD 2024; NJGIN 2024; NOAA 2022
Note: % = Percent

Table 11-21. Number of Facilities in Category 3 SLOSH Hazard Area, by Lifeline Category

Jurisdiction	Number of Facilities in Category 3 SLOSH Hazard Area, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Jurisdiction Total
Bayonne (C)	0	10	3	6	0	8	16	10	5	58	50.0%
East Newark (B)	0	0	0	0	0	0	1	0	0	1	11.1%
Guttenberg (T)	0	0	0	0	0	0	0	0	0	0	0.0%
Harrison (T)	1	2	0	2	1	4	3	1	2	16	35.6%
Hoboken (C)	1	3	28	5	8	27	9	6	45	132	94.3%
Jersey City (C)	1	19	5	20	3	48	64	12	28	200	46.1%
Kearny (T)	0	10	0	7	0	5	21	11	0	54	50.5%
North Bergen (T)	0	3	0	1	2	1	7	10	2	26	26.0%
Secaucus (T)	5	3	1	2	4	5	22	6	6	54	64.3%
Union City (C)	0	0	0	0	0	0	1	0	0	1	1.1%
Weehawken (T)	0	0	1	0	0	1	11	3	2	18	39.1%
West New York (T)	0	0	0	0	0	1	0	2	0	3	6.3%
Hudson County (Total)	**8**	**50**	**38**	**43**	**18**	**100**	**155**	**61**	**90**	**563**	**45.4%**

Source: Hudson County 2024; HIFLD 2024; NJGIN 2024; NOAA 2022

Table 11-22. Number of Facilities in Category 4 SLOSH Hazard Area, by Lifeline Category

Jurisdiction	Number of Facilities in Category 1 SLOSH Hazard Area, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Jurisdiction Total
Bayonne (C)	0	10	6	6	1	14	20	11	7	75	64.7%
East Newark (B)	0	0	1	0	1	0	1	0	0	3	33.3%
Guttenberg (T)	0	0	0	0	0	0	0	0	0	0	0.0%
Harrison (T)	1	3	1	2	1	8	6	1	5	28	62.2%
Hoboken (C)	1	3	29	5	8	28	9	6	45	134	95.7%
Jersey City (C)	1	19	5	22	3	52	74	12	30	218	50.2%
Kearny (T)	0	10	0	7	0	5	21	11	0	54	50.5%
North Bergen (T)	0	3	0	1	2	4	10	11	3	34	34.0%
Secaucus (T)	5	3	1	2	4	7	26	6	6	60	71.4%
Union City (C)	0	0	0	0	0	0	1	0	0	1	1.1%
Weehawken (T)	0	0	1	0	0	1	11	3	2	18	39.1%
West New York (T)	0	0	0	0	0	1	0	2	0	3	6.3%
Hudson County (Total)	**8**	**51**	**44**	**45**	**20**	**120**	**179**	**63**	**98**	**628**	**50.7%**

Source: Hudson County 2024; HIFLD 2024; NJGIN 2024; NOAA 2022

Table 11-23. Estimated Impacts to Critical Facilities for the 100-Year MRP Event

Name	Loss of Days	Average Percent Probability of Sustaining Damage 100-Year Mean Return Period Hurricane			
		Minor	Moderate	Severe	Complete
Communications	0	4.1%	0.8%	<0.1%	0.0%
Energy	0	4.6%	0.5%	<0.1%	0.0%
Food, Hydration, Shelter	0	4.1%	1.4%	<0.1%	0.0%
Hazardous Materials	0	5.5%	2.0%	0.5%	<0.1%
Health and Medical	0	2.4%	0.2%	0.0%	0.0%
Safety and Security	300	7.8%	9.1%	0.2%	<0.1%
Transportation	0	4.5%	0.7%	<0.1%	0.0%
Water Systems	0	4.2%	0.4%	<0.1%	0.0%

Source: Hazus v6.1; Hudson County 2024; HIFLD; NJGIN 2024

Table 11-24. Estimated Impacts to Critical Facilities for the 500-Year MRP Event

Name	Loss of Days	Average Percent Probability of Sustaining Damage 500-Year Mean Return Period Hurricane			
		Minor	Moderate	Severe	Complete
Communications	0	16.0%	7.9%	1.0%	<0.1%
Energy	0	17.9%	9.2%	1.2%	0.0%
Food, Hydration, Shelter	0	15.8%	9.8%	0.7%	<0.1%
Hazardous Materials	0	16.4%	12.1%	5.2%	0.5%
Health and Medical	2	11.8%	8.6%	0.1%	0.0%
Safety and Security	300	12.7%	12.1%	0.5%	<0.1%
Transportation	0	18.3%	10.1%	1.5%	0.0%
Water Systems	0	17.7%	8.6%	1.2%	0.0%

Source: Hazus v6.1; Hudson County 2024; HIFLD; NJGIN 2024

11.2.4 Economy

Severe weather events can have both short- and long-lasting impacts on the economy. High wind events may threaten safety, damage buildings, and impact the economy, including loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Recovery and clean-up costs can also be costly and impact the economy as well (NJOEM 2024). When a business is closed during storm recovery, there is lost economic activity in the form of day-to-day business and wages to employees. Overall, economic impacts include the loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure

(power lines, gas lines, electrical systems) could suffer damage, resulting in the loss of power, which can impact business operations and heating or cooling provision to the population.

Debris management can be costly and impact the local economy. Hazus estimates the amount of debris that might be produced as result of the 100- and 500-year MRP wind events. Table 11-25 summarizes the estimated debris by municipality, which should be considered a lower-bound analysis. Because the estimated debris production does not include debris generated by flooding, this is likely a conservative estimate and could be higher if multiple impacts occur.

Table 11-25. Debris Production for 100- and 500-Year Mean Return Period Event Winds

	Brick and Wood (tons)		Concrete and Steel (tons)		Tree (tons)		Eligible Tree Volume (cubic yards)	
Jurisdiction	**100-Year**	**500-Year**	**100-Year**	**500-Year**	**100-Year**	**500-Year**	**100-Year**	**500-Year**
Bayonne (C)	3,401	18,243	0	120	1,792	4,362	15,024	35,995
East Newark (B)	60	245	0	1	16	36	135	304
Guttenberg (T)	216	2,618	0	19	8	33	87	335
Harrison (T)	563	2,291	0	11	140	308	1,029	2,321
Hoboken (C)	2,084	20,707	0	162	78	271	744	2,572
Jersey City (C)	5,867	36,268	0	144	3,801	10,670	24,377	68,607
Kearny (T)	1,296	5,855	0	34	3,876	10,017	14,506	35,739
North Bergen (T)	1,078	9,460	0	37	1,367	4,785	8,057	28,338
Secaucus (T)	1,110	6,601	0	20	2,225	6,765	11,268	34,488
Union City (C)	1,034	7,323	0	25	105	351	942	3,169
Weehawken (T)	368	3,527	0	22	300	1,008	2,682	9,006
West New York (T)	540	4,335	0	16	77	310	566	2,231
Hudson County (Total)	**17,617**	**117,473**	**0**	**611**	**13,785**	**38,916**	**79,417**	**223,106**

Source: Hazus v6.1; NJOIT 2024; Microsoft BING 2019

During a 100-year MRP wind event, Hudson County is expected to generate significant amounts of debris. The City of Jersey City stands out with the highest estimates, producing 5,867 tons of brick and wood debris. Additionally, tree debris in the City of Jersey City is projected at 3,801 tons, with an eligible tree volume of 24,377 cubic yards. Overall, Hudson County is anticipated to produce a total of 17,617 tons of brick and wood debris during this event. Tree debris across the County is estimated at 13,785 tons, with an eligible tree volume reaching 79,417 cubic yards.

In the event of a 500-year MRP wind event, the debris estimates increase substantially. The City of Jersey City is projected to generate the highest amount of debris, with 36,268 tons of brick and wood debris. Additionally, tree debris in the City of Jersey City is estimated at 10,670 tons, with an eligible tree volume of 68,607 cubic yards. Overall, Hudson County is expected to produce a total of 117,473 tons of brick and wood debris during a 500-year MRP event. Tree debris across the County is estimated at 38,916 tons, with an eligible tree volume reaching 223,106 cubic yards.

11.2.5 Natural, Historic and Cultural Resources

NATURAL

The impact of severe weather events on the environment varies, but researchers are finding that the long-term impacts of more severe weather can be destructive to the natural and local environment. National organizations such as USGS and NOAA have been studying and monitoring the impacts of extreme weather phenomena as it impacts long term climate change, streamflow, river levels, reservoir elevations, rainfall, floods, landslides, erosion, etc. For example, severe weather that creates longer periods of rainfall can erode natural banks along waterways and degrade soil stability for terrestrial species. Tornadoes can tear apart habitats causing fragmentation across ecosystems (United States Environmental Protection Agency 2023).

Researchers also believe that a greater number of diseases will spread across ecosystems because of impacts that severe weather and climate change will have on water supplies (United States Climate Resilience Toolkit 2016). Overall, as the physical environment becomes more altered, species will begin to contract or migrate in response, which may cause additional stressors to the entire ecosystem within Hudson County. The impacts of hurricane related winds on the environment typically take place over a larger area. Where these events occur, widespread, severe damage to tree and plant species is likely. This includes uprooting or destruction of trees and an increased threat of wildfire in areas where dead trees are not removed. Chapter 9 (Flood) provides additional environmental impacts due to flooding from heavy rainfalls.

HISTORIC

Winds associated with severe weather can cause significant damage to historic infrastructure. Historic sites are particularly vulnerable due to their age and construction prior to modern building standards. The materials used in these structures may be aged and prone to maintenance issues, making them more susceptible to damage. Additionally, any damage repair may require compliance with stringent landmark laws, complicating and increasing the cost of repairs.

Historic buildings are at risk of structural damage during flood events caused by thunderstorm or hurricane rains. Many historic resources and structures were built close to waterways, which increases their flood risk. Severe flood events could result in devastating loss of life and property in and around these historical landmarks.

CULTURAL

Winds associated with severe weather can cause significant damage or destruction to cultural resources. The historic buildings that house such resources may be particularly vulnerable due to their construction prior to modern building standards, which may not withstand high winds. The materials used in these structures may be aged and prone to maintenance issues, further increasing their susceptibility to damage.

Cultural heritage sites exposed to severe weather are subject to weathering and deterioration. Outdoor cultural events are at risk, as severe weather can lead to postponements or cancellations. The vulnerability of cultural resources is heightened by their irreplaceable nature. Damage to these sites can result in the loss of unique historical and cultural artifacts, which cannot be easily restored or replaced. Additionally, any damage repair may require compliance with stringent landmark laws, complicating and increasing the cost of repairs.

11.3 Future Changes That May Affect Risk

Understanding future changes that affect vulnerability can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The following sections examine potential conditions that may affect hazard vulnerability.

11.3.1 Potential or Planned Development

Understanding future changes that impact vulnerability in Hudson County is crucial for planning development and ensuring appropriate mitigation, planning, and preparedness measures. New development and residents will face hurricane and tropical storm hazards, but increased standards and codes may reduce their vulnerability to wind and flood-related hazards compared to older buildings.

New development will alter the landscape, replacing open land and vegetation with buildings, roads, and other infrastructure. This transformation can make surfaces that were once permeable and moist become impermeable and dry, increasing susceptibility to fires caused by lightning.

As noted in Chapter 3 (County Profile), areas targeted for future growth and development have been identified across the County. These areas are vulnerable to severe storm events, and new development sites should adhere to building codes that provide high wind protection and flood-proofing measures. Specific areas of recent and new development are detailed in tables and hazard maps included in the jurisdictional annexes in Volume II of this plan.

11.3.2 Projected Changes in Population

The New Jersey Department of Labor and Workforce Development produced populations projections by County from 2014 to 2019, 2024, 2029, and 2034. According to these projections, Hudson County is projected to have an increase in population in the upcoming years. These projection totals include a population of 747,400 by 2029, and 766,500 by 2034 (State of New Jersey 2017).

An increase in population amplifies severe weather risks. Higher density means more people are vulnerable to casualties and injuries, especially in urban areas. Resource demand rises, leading to potential shortages during crises. More infrastructure is needed, which can be costly to repair after severe weather. Urbanization often reduces natural landscapes that mitigate weather impacts, increasing flood risks. Emergency response systems can be overwhelmed, delaying rescue efforts. Vulnerable groups may need extra resources, further straining services. Overall, a growing population heightens severe weather challenges and risks.

11.3.3 Climate Change

Future climate change in New Jersey, including rising temperatures and increased precipitation, will heighten the risk of severe weather. By 2050, temperatures could rise by 4.1 to 5.7 °F, leading to hotter summers and milder winters. Precipitation is expected to increase, with more intense rain events and potential for prolonged droughts. These changes will make storms more frequent and severe, impacting the region's vulnerability to extreme weather events.

11.3.4 Other Identified Conditions

As discussed in previous sections, most studies project that the County will see an increase in average annual temperatures and precipitation. As the climate warms and other changes in climate continue to unfold, the intensity of summer weather may change, producing more ideal conditions for severe storms to form. It is anticipated that the County will continue to experience direct and indirect impacts of severe weather events annually that may induce secondary hazards such as infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.