5.12 Severe Storm

2023 SHMP Update Changes

- The hazard profile was reorganized and significantly enhanced to include detailed descriptions of the following: hazard definition, location, extent, previous occurrences, and probability of future occurrences (including how future conditions may impact the hazard).
- Information was updated regarding the current population affected by severe storms.
- Severe storm events that occurred in the State of West Virginia (the State) from January 1, 2018, through December 31, 2022, were researched and added for this 2023 State Hazard Mitigation Plan (SHMP) Update.
- New and updated figures from federal, State, and local agencies are incorporated.
- Analyzed State asset exposure to severe storm events and assessed local vulnerabilities.

5.12.1 Hazard Profile

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of future conditions) and vulnerability assessment for the severe storm hazard in West Virginia.

Hazard Description

Wind and severe storms pose risks to West Virginia. High winds, thunderstorms, lightning, hail, tornadoes, and remnants of hurricanes can cover vast areas of the State quickly and without significant warning, leading to flooding, lightning-initiated fires, and significant structural damage (West Virginia Emergency Management Division 2018). Severe storms can pose a major potential threat to the State's population because of their frequency, the size of devastated areas, the population affected, and the potential damage scale. Severe storms in West Virginia also have historically caused secondary hazards such as flooding, mudflows, landslides, electrical outages, and other impacts.

Key Terms

Thunderstorm - A thunderstorm is a rain shower during which you hear thunder. Since thunder comes from lightning, all thunderstorms have lightning (NOAA n.d.).

Hail - Hail is a form of precipitation consisting of solid ice that forms inside thunderstorm updrafts (NOAA n.d.).

Tornado - A tornado is a narrow, violently rotating column of air that extends from a thunderstorm to the ground (NOAA n.d.).

Hurricane - Hurricanes are large, swirling storms. They produce winds of 119 kilometers per hour (74 mph) or higher (NASA 2017).

Thunderstorm

A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS 2021). 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. All thunderstorms contain lightning. Thunderstorms may occur singly, in clusters, or in lines. It is possible for several thunderstorms to affect one location over a few hours or for a single, slow-moving storm to affect one location for an extended period. Thunderstorms can contribute to other hazard events, such as flooding, strong straight-line winds, tornadoes, hail, and lightning, as well as the possibility of lightning-initiated fires. Severe thunderstorms are officially defined as thunderstorms that produce one or more of the following:

- Winds of 58 mph or higher
- Hail 1 inch in diameter (quarter-sized) or larger
- Tornadoes

Hailstorm

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

Tornado

A tornado is a narrow, violently rotating column of air that extends from a thunderstorm to the ground. Because wind is invisible, it is hard to see a tornado unless it forms a condensation funnel made up of water droplets, dust, and debris (NOAA n.d.). They typically spawn from strong winds associated with thunderstorms and hurricanes. While roughly 1,000 tornadoes a year are generated by thunderstorms, relatively few fully touch the ground. As wind speeds increase, the level of destruction continues to increase as well.

High Wind

Wind begins with differences in air pressures. It is a rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated with other severe weather events such as thunderstorms, tornadoes, hurricanes, and tropical storms (NWS 2012). Different types of damaging winds include straight-line wind, downdraft, downburst, microburst, gust front, derecho, bow echo, and hook echo. Each wind type is described below (NOAA n.d.):

- **Straight-line wind** is a term used to define any thunderstorm wind that is not associated with rotation. Straight-line winds are the movement of air from areas of higher pressure to areas of lower pressure – the greater the difference in pressure, the stronger the winds. It is used mainly to differentiate from tornadic winds.
- A **downdraft** is a small-scale column of air that rapidly sinks toward the ground and usually results in a downburst.
- A **downburst** is a strong downdraft with horizontal dimensions larger than 2.5 miles, resulting in an outward burst or damaging winds on or near the ground. It is usually associated with thunderstorms but can occur with rain storms too weak to produce thunder.

- A **microburst** is a small, concentrated downburst that produces an outward burst of damaging winds near the surface. It is typically short-lived, lasting only 5 to 10 minutes, with maximum wind speeds of up to 168 miles per hour (mph).
- A **gust front** is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. It is characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm.
- A **derecho** is a long-lived windstorm associated with rapidly moving precipitation or thunderstorms. If wind damage swatch is more than 240 miles and includes gusts of wind that reach 58 mph or greater, then the event can be classified as a derecho.
- A **bow echo** is a radar echo that is linear but bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo (crest). A bow echo can be more than 300 kilometers long, last for several hours, and produce extensive swaths of wind damage at the ground (NOAA 2023).
- A **hook echo** is a radar echo that is the most recognized and well-known radar signature for tornadic supercells. This "hook-like" feature occurs when the strong counter-clockwise winds circling the mesocyclone (rotating updraft) are strong enough to wrap precipitation around the rain-free updraft area of the storm (NOAA 2022).

Hurricane

Tropical cyclones (hurricanes) are fueled by a different heat mechanism than other cyclonic windstorms such as nor'easters and polar lows. The characteristic that separates a tropical cyclone from another cyclonic system is that at any height in the atmosphere, the center of a tropical cyclone will be warmer than its surroundings, a phenomenon called "warm core" storm systems (NOAA 2011). 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. Tropical cyclones begin as disturbed areas of weather, often referred to as tropical waves. As the storm organizes, it is designated as a tropical depression.

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds of 39 to 73 mph and heavy rain. A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 mph or higher. Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic coast of the United States and impact the eastern seaboard or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England before moving offshore and heading east (NOAA 2011). By the time a storm is classified as a hurricane and arrives in West Virginia, it has most likely weakened into a tropical storm or depression. These storms still pose a danger from torrential rains and high winds.

Location

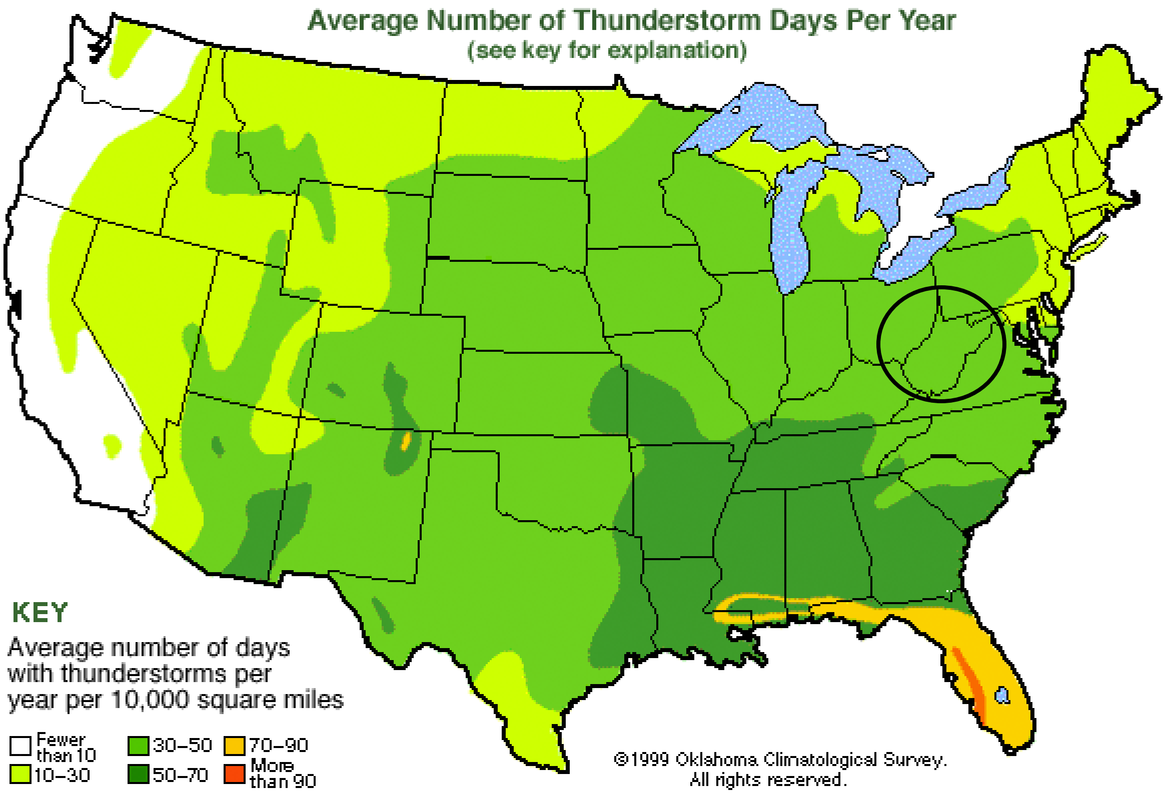
All communities within West Virginia are subject to impacts of severe storms. Areas that are subject to increased flooding and extreme winds are particularly vulnerable. Higher elevations in mountainous areas tend to experience severe storms as snowfall and winter weather. Flatter areas tend to be more ideal for tornado longevity, making those areas more at risk for that hazard.

Thunderstorm

Thunderstorms tend to take place during the spring and summer months and during the warmest times of the day, which tend to be late afternoon and early evening (NOAA n.d.).

Figure 5.12-1 displays thunderstorm days per year across the United States. According to the map, West Virginia is likely to have between 30-50 thunderstorms per year, which is similar to its surrounding states (University Corporation for Atmospheric Research 2023).

Figure 5.12-1: Average Number of Thunderstorms in the U.S.

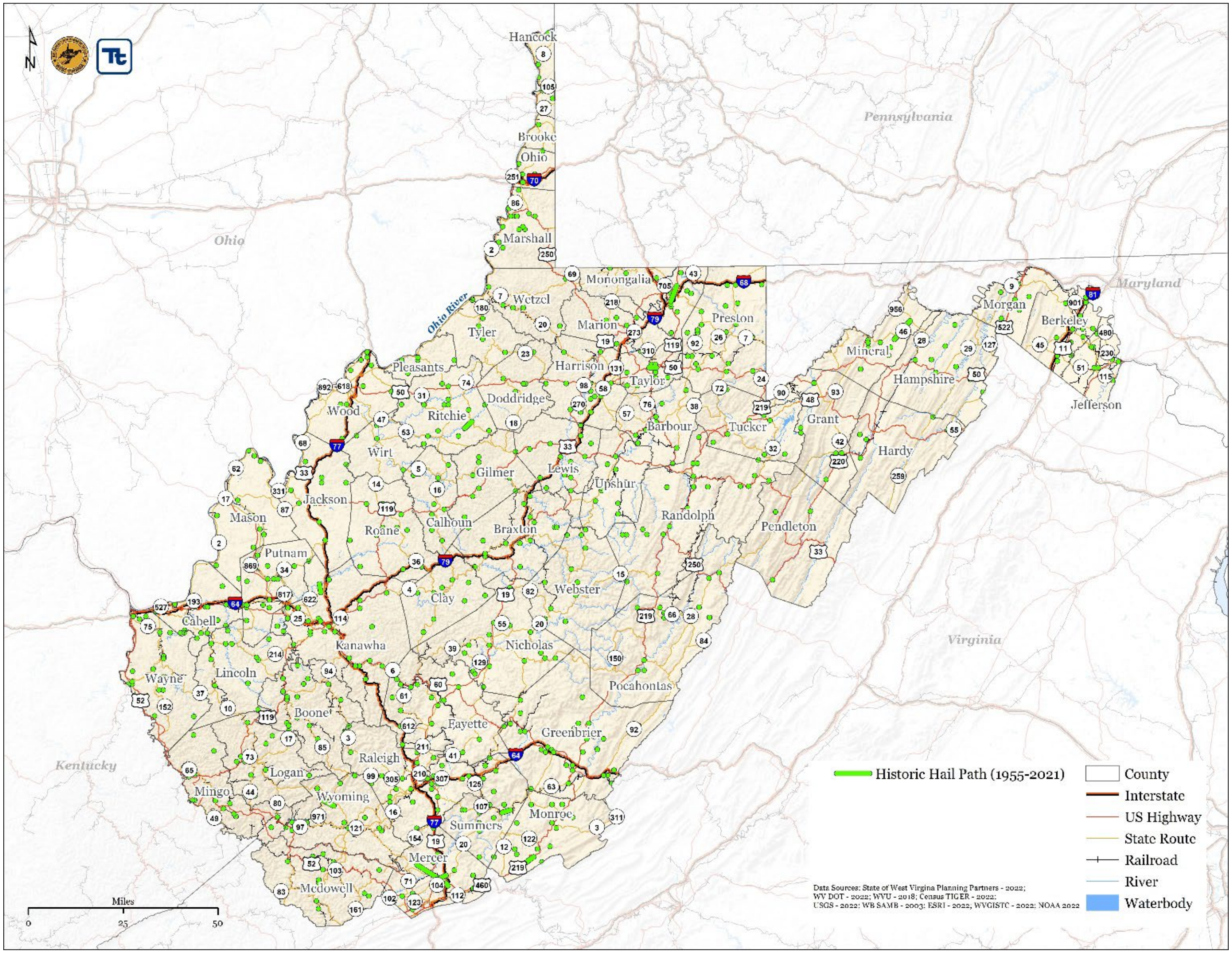


Source University Corporation for Atmospheric Research 2023
Note: West Virginia is identified within the black outlined circle

Hailstorm

Hailstorms can form anywhere; however, they are more likely to fall in areas that have the most thunderstorms (refer to Figure 5.12-1). The longer a hailstone spends in the clouds, the larger it becomes as more droplets continue to freeze. Hail falls when it becomes heavy enough to overcome the strength of the thunderstorm updraft and is pulled to the earth by gravity. Smaller hailstones may be blown away from the updraft by horizontal winds, so larger hail typically falls closer to the updraft than smaller hail (NOAA n.d.). Figure 5.12-2 pinpoints historic hail locations that have occurred in West Virginia.

Figure 5.12-2: Historic Hail Locations



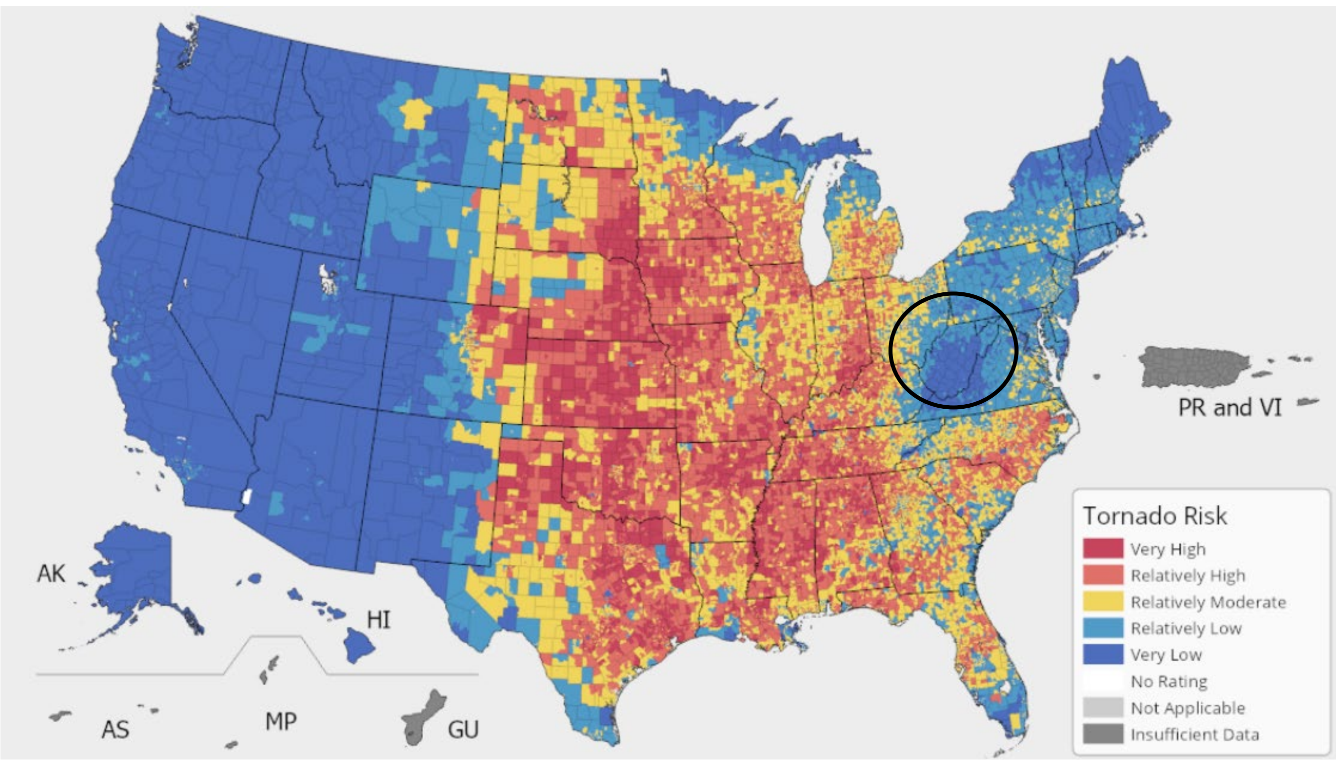
Tornado

Roughly 1,200 tornadoes hit the United States every year, with the majority located in Tornado Alley, which refers to the central United States; however, violent tornadoes have been experienced by all 50 states. While the extent of tornado damage is usually localized, the extreme winds of the tornado vortex can be among the most destructive on earth as they move through populated, developed areas and can affect nearby areas. The peak of tornado season is between June and July, and tornadoes typically strike during the warmer parts of the day, mainly between 4:00 pm and 9:00 pm (NOAA n.d.).

Tornado movement is characterized in two ways: direction and speed of the spinning winds and forward movement of the tornado and storm track. Rotational wind speeds of the vortex can range from 100 mph to more than 250 mph. In addition, the speed of forward motion can be 0 to 45 or 50 mph. Therefore, some estimates place the maximum velocity (combination of ground speed, wind speed, and upper winds) of tornadoes at about 300 mph. The forward motion of the tornado path can be a few hundred yards or several hundred miles in length. The width of tornadoes can vary but generally range in size from less than 100 feet to more than a mile in width. Some tornadoes never touch the ground and are short-lived, while others may touch the ground several times.

Figure 5.12-3 displays the Tornado Risk Index for the United States (West Virginia displayed within the black circle). According to the National Risk Index, the majority of the State has between a very low to relatively low risk to tornadoes, with portions of the northern tip of the State having a relatively moderate risk.

Figure 5.12-3: National Risk Index, Tornado Risk Index Score

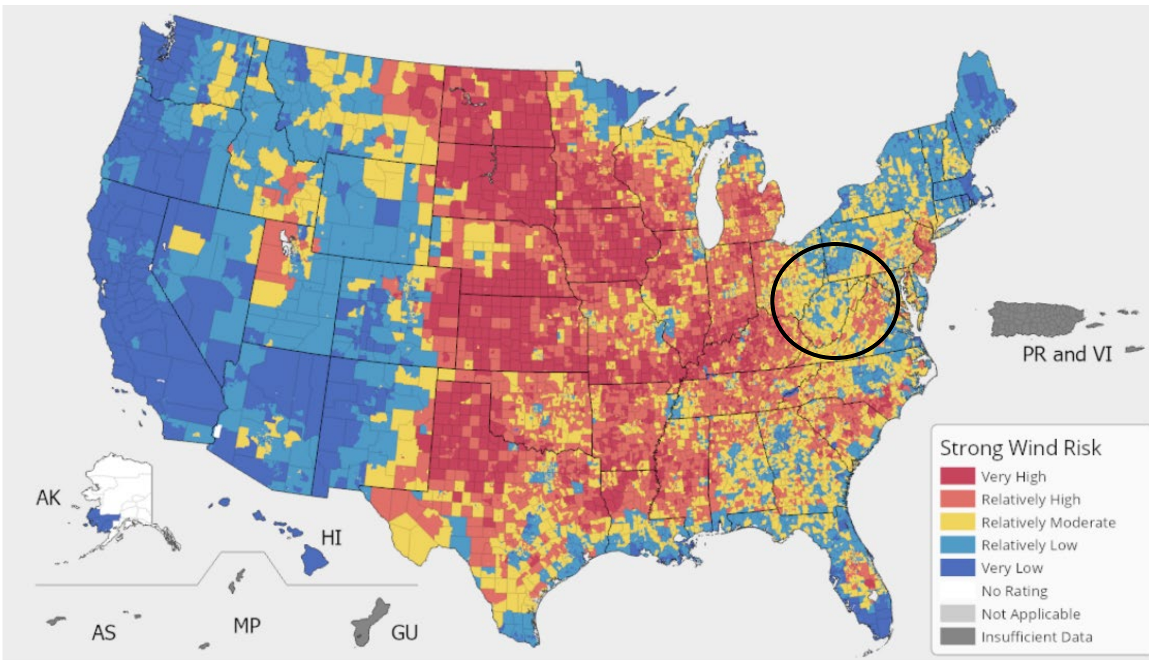


Source: FEMA 2023
Note: West Virginia is identified within the black outlined circle

High Wind

Severe storms have the power to produce powerful winds; therefore, strong, and powerful winds have a higher chance of occurring in locations that are more likely to experience these storms (NOAA n.d.). In addition, high wind events may occur without a thunderstorm, tornado, or hurricane present and can be just as dangerous and destructive as those hazards. Figure 5.12-4 displays the Strong Wind Risk Index for the United States (West Virginia displayed within the black circle). According to the National Risk Index, the majority of the State has a relatively moderate risk to strong winds, with portions of the State having relatively low risk and relatively high risk.

Figure 5.12-4. National Risk Index, Strong Wind Risk Index Score

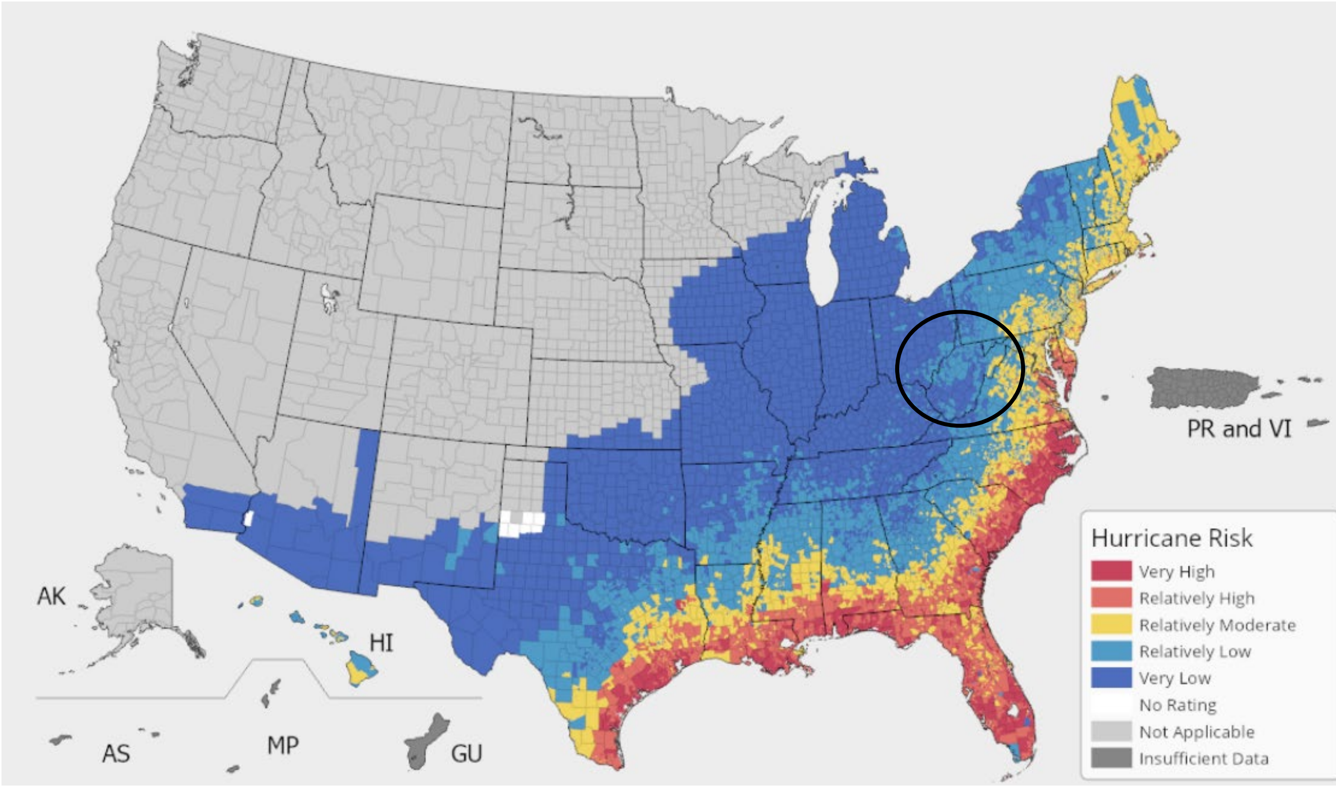


Source: FEMA 2023
Note: West Virginia is identified within the black outlined circle

Hurricane

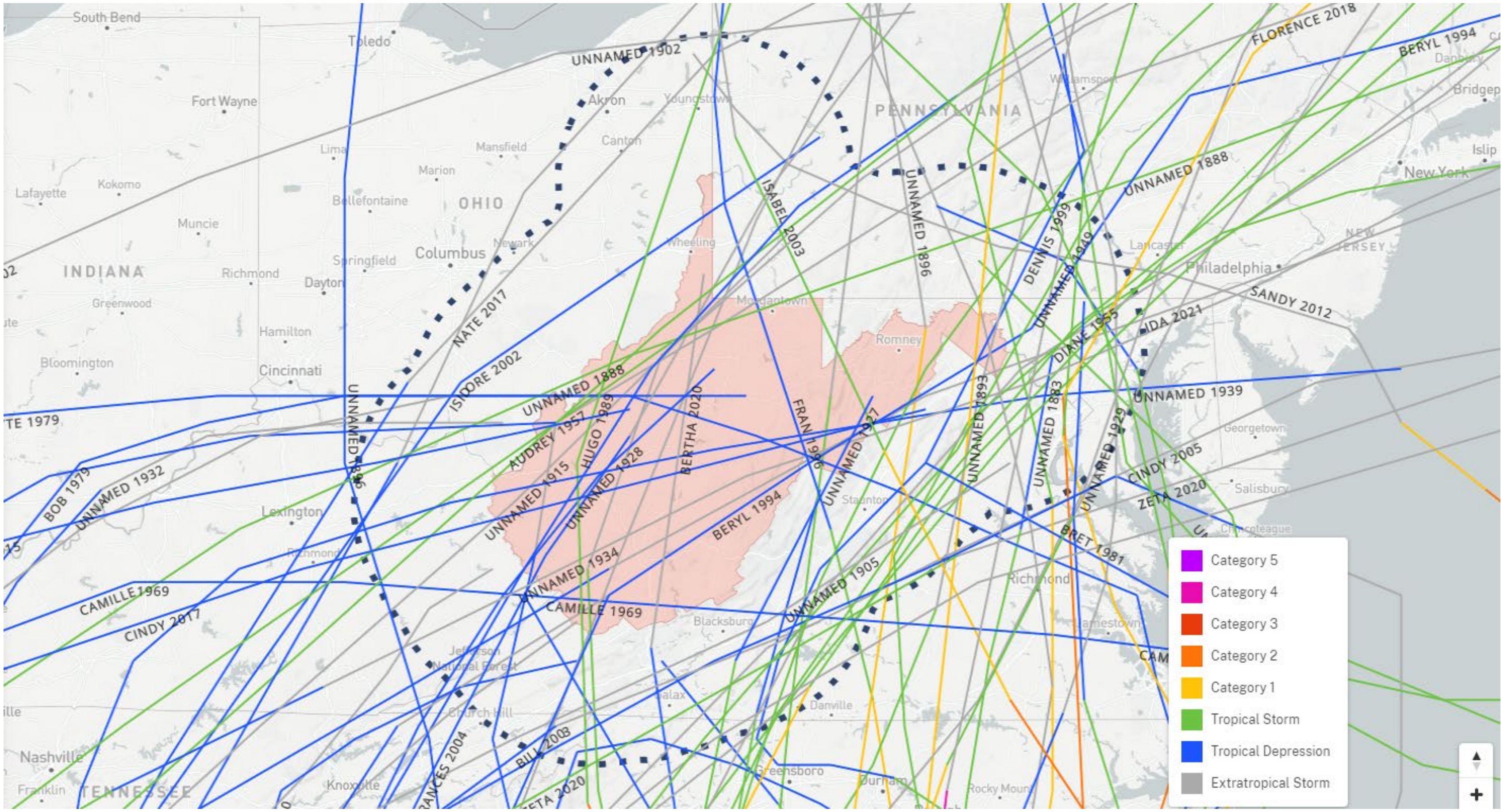
Hurricanes are most likely to form during hurricane season, which is from June to November each year. Each hurricane's path is predicted on a case-by-case basis which allows scientists to be able to consider information from the specific storm as well as what is known about the conditions of the atmosphere and the ocean (University Corporation for Atmospheric Research 2022). Figure 5.12-5 displays the Hurricane Risk Index for the United States (West Virginia displayed within the black circle). According to the National Risk Index, the State has between a very low to relatively low risk to hurricanes. Figure 5.12-6 depicts historic hurricane pathways that have passed through West Virginia.

Figure 5.12-5. National Risk Index, Hurricane Risk Index Score



Source: FEMA 2023
Note: West Virginia is identified within the black outlined circle

Figure 5.12-6: Historic Hurricane Pathways



Source: NOAA 2023

EXTENT

Thunderstorm

Severe thunderstorm 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 statements, watches, and warnings for thunderstorms:

- **Special Weather Statement:** Issued for strong storms that are below severe levels but may have impacts. Usually reserved for the threat of wind gust of 40–58 mph or small hail <1 inch.
- **Severe Thunderstorm Watch:** Severe thunderstorms with large hail, damaging winds, and/or tornadoes are possible, but the exact time and location of storm development is still uncertain. A watch means be prepared for storms.
- **Severe Thunderstorm Warning:** A severe thunderstorm is imminent or occurring; it is either detected by weather radar or reported by storm spotters. A severe thunderstorm is one that produces winds 58 mph or stronger and/or hail 1 inch in diameter or larger. A warning means to take shelter (NWS 2020).

The National Weather Service has five risk categories for severe weather: marginal, slight, enhanced, moderate, and high. The probabilistic forecast directly expresses the best estimate of a severe weather event occurring within 25 miles of a point (NWS 2022). Figure 5.12-7 details the thunderstorm risk categories.

Figure 5.12-7: Thunderstorm Risks

Source: NWS 2022

Hailstorm

Large hail size is said to be the greatest contributor to insured losses from a thunderstorm, making it one of the more expensive hazards. By using historic hailstone size and intensity data, it is easier to predict the full range of possible future outcomes in models (Grieser and Hill 2019).

The Torro Hailstorm Intensity Scale was developed to measure and categorize hailstorms. A member of the Tornado and Storm Research Organization (TORRO) in England created a 0 to 10 scale that begins at "no damage" and ends at catastrophic damage. More intense hailstorms cause lasting impacts on property, homes and have the ability to severely injure people and animals (TORRO n.d.). Table 5.12-1 breaks down the TORRO scale by category, and Table 5.12-2 shows hail size and diameter and how it may relate to common objects.

Table 5.12-1. The Torro Hailstorm Intensity Scale

Scale	Intensity Category	Typical Hail Diameter (mm)	Typical Damage Impacts
H0	Hard Hail	5	No Damage
H1	Potentially Damaging	5-15	Slight general damage to plants and crops
H2	Significant	10-20	Significant damage to fruit, crops, and vegetation
H3	Severe	20-30	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	25-40	Widespread glass damage, vehicle body damage
H5	Destructive	30-50	Wholesale destruction of glass and damage to roofs, risk of injuries
H6	Destructive	40-60	Bodywork of grounded aircraft dented; brink walls pitted
H7	Destructive	50-75	Severe roof damage, risk of serious injuries
H8	Destructive	60-90	Severe damage to aircraft bodywork
H9	Super Hailstorms	75-100	Extensive structural damage. Risk of severe or fatal injuries
H10	Super Hailstorms	>100	Extensive structural damage. Risk of severe or fatal injuries

Source TORRO n.d.

Table 5.12-2. Hail Size and Diameter

Size Code	Maximum Diameter (mm)	Description
0	5-9	Pea
1	10-15	Mothball
2	16-20	Marble, grape
3	21-30	Walnut
4	31-40	Pigeon's egg
5	41-50	Golf ball
6	51-60	Hen's egg
7	61-75	Tennis ball
8	76-90	Large orange
9	91-100	Grapefruit
10	>100	Melon

Source TORRO n.d.

Tornado

Wind speeds in tornadoes range from values below that of hurricane speeds to more than 300 mph. Unlike hurricanes, which produce wind speeds of similar values over relatively widespread areas (when compared to tornadoes), the maximum winds in tornadoes are often confined to extremely small areas and vary substantially over very short distances, even within the funnel itself.

The Fujita scale, introduced in 1971 by Dr. Ted Fujita, provided a way to characterize tornadoes based on the damage they produced and was able to relate that damage to the fastest quarter-mile wind at the height of a damaged structure. The Enhanced Fujita Scale or EF Scale, which became operational on February 1, 2007, is used to assign a tornado a 'rating' based on estimated wind speeds and related damage (refer to Figure 5.12-8). When tornado-related damage is surveyed, it is compared to a list of Damage Indicators (DIs) and Degrees of Damage (DoD) which help estimate better the range of wind speeds the tornado likely produced. From that, a rating (from EF0 to EF5) is assigned. Figure 5.12-8 describes the Enhanced Fujita Tornado Scale.

Tornado watches and warnings 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 SPC 2018).

Figure 5.12-8: Enhanced Fujita Scale

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 NOAA n.d.

High Wind

Windstorms are generally defined as sustained wind speeds of 40 mph or greater, lasting for 1 hour or longer, or winds of 58 mph or greater for any duration. The Beaufort Wind Scale is one of the first scales to estimate wind speeds and effects. It was created by Britain's Admiral Sir Francis Beaufort; he developed the scale in 1805 to help sailors estimate the winds via visual observations. The scale starts with 0 and goes to a force of 12 (NOAA 2022).

Figure 5.12-9. Beaufort Scale

Beaufort Number	Wind Speed (miles/hour)	Wind Speed (km/hour)	Wind Speed (knots)	Description	Wind Effects on Land
0	< 1	< 1	< 1	Calm	Calm. Smoke rises vertically.
1	1-3	1-5	1-3	Light Air	Wind motion visible in smoke.
2	4-7	6-11	4-6	Light Breeze	Wind felt on exposed skin. Leaves rustle.
3	8-12	12-19	7-12	Gentle Breeze	Leaves and smaller twigs in constant motion.
4	13-18	20-28	11-16	Moderate Breeze	Dust and loose paper are raised. Small branches begin to move.
5	19-24	29-38	17-21	Fresh Breeze	Small trees begin to sway.
6	25-31	39-49	22-27	Strong Breeze	Large branches are in motion. Whistling is heard in overhead wires. Umbrella use is difficult.
7	32-38	50-61	28-33	Near Gale	Whole trees in motion. Some difficulty experienced walking into the wind.
8	39-46	62-74	34-40	Gale	Twigs and small branches break from trees. Cars veer on road.
9	47-54	75-88	41-47	Strong Gale	Larger branches break from trees. Light structural damage.
10	55-63	89-102	48-55	Storm	Trees broken and uprooted. Considerable structural damage.
11	64-72	103-117	56-63	Violent Storm	Widespread damage to structures and vegetation.
12	> 73	> 117	> 64	Hurricane	Considerable and widespread damage to structures and vegetation. Violence.

Source: NWS 2022

Hurricane

The extent of a hurricane or tropical storm is commonly categorized in accordance with the Saffir-Simpson Hurricane Wind Scale, which assigns a designation of tropical storm for storms with sustained wind speeds below 74 mph and a hurricane category rating of 1–5 based on a hurricane's increasing 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. Tropical storms and Category 1 and 2 storms are still dangerous and require preventative measures (NWS n.d.). Table 5.12-3 below shows hurricane categories and the type of damage they produce.

Table 5.12-3. Saffir-Simpson Hurricane Wind Scale

Category	Sustained Winds (miles per hour)	Types of Damage Due to Hurricane Winds
1	74-95	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly 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)	111-129	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (Major)	130-156	Catastrophic damage will occur: Well-built framed homes 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 or higher	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.
Other non-hurricane classifications are tropical storms (39-73 miles per hour) and tropical depressions (0-38 miles per hour)		

Source: NOAA n.d.

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. The 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.

The HAZUS 1,000-year recurrence hurricane analysis shows that the State is likely to experience tropical storm to Category 1 hurricane wind equivalents from a 1,000-year event.

Warning Time

Thunderstorm

As described in the Extent section for thunderstorms, National Weather Service will issue a severe thunderstorm watch when conditions are favorable for the development of severe thunderstorms, and a warning when a severe thunderstorm is occurring, is detected by National Weather Service Doppler Radar, or a reliable report has been received. A severe thunderstorm watch lasts around 6 hours and covers a relatively large area; a watch means for individuals in the area to be alert. A severe thunderstorm warning is issued for smaller, more specific locations and generally last for less than one hour; a warning means for individuals to take action at that time (NWS 2023).

These warning times may also be applied to the hail, tornado, and high wind hazards, as these phenomena generally all occur during a severe thunderstorm. In addition to these warning times, a location may have a tornado siren to warn its residents and visitors of an actively occurring tornado; unfortunately, the timeframe for a tornado siren is only a few minutes until potential impacts are felt. An issuance for a severe thunderstorm watch or warning may occur during a hurricane event as well.

Hurricane

The National Weather Service 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 the watches and warnings:

- **Hurricane/Typhoon Warning** is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical 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.
- **Hurricane Watch** is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm-force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm-force winds.
- **Tropical Storm 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, subtropical, or post-tropical storm. A severe thunderstorm watch or warning may occur simultaneously with a hurricane or tropical storm watch or warning.
- **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 (NHC 2010).

It is unlikely for a hurricane watch, hurricane warning, tropical storm watch, or tropical storm warning to be issued for the State since it is not coastal. Instead, West Virginia is more likely to experience warnings for the severe thunderstorms which may be produced from a hurricane or tropical storm.

PREVIOUS OCCURRENCES AND LOSSES

Federal Emergency Management Agency (FEMA) Disaster Declarations

Between 1953 and 2022, the State was included in 55 disaster (DR) or emergency (EM) declarations for severe storm-related events. These events are classified as one or a combination of the following incident types: Flooding, Hurricane, and Severe Storm. Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2023).

Table 5.12-4. Severe Storm-Related Federal Declarations (1953 to 2022)

Date(s) of Event	Event Type	Federal Designation	Counties Affected
March 9, 1962	Flood	DR-125-WV*	Statewide
March 13, 1963	Flood	DR-147-WV*	Statewide
March 20, 1964	Flood	DR-165-WV*	Statewide
September 3, 1969	Severe Storms, Flooding	DR-278-WV	Greenbrier, Nicholas, Pocahontas
September 24, 1969	Flood	DR-279-WV	Greenbrier
February 27, 1972	Flood	DR-323-WV	Boone, Kanawha, Lincoln, Logan, Mingo, Raleigh, Wyoming
July 3, 1972	Flood	DR-344-WV	Barbour, Berkeley, Brooke, Greenbrier, Hampshire, Hancock, Hardy, Jefferson, Marshall, Monongalia, Monroe, Morgan, Ohio, Preston, Wetzel
August 23, 1972	Flood	DR-349-WV	Logan, McDowell, Mingo, Wyoming
January 29, 1974	Flood	DR-416-WV	Kanawha, Lincoln, Logan, Mingo, Wayne
April 11, 1974	Flood	DR-426-WV	Fayette, Greenbrier, Raleigh, Wyoming
September 12, 1975	Flood	DR-481-WV	Marshall, Ohio
April 7, 1977	Flood	DR-531-WV	Cabell, Greenbrier, Lincoln, Logan, McDowell, Mercer, Mingo, Raleigh, Summers, Wayne, Wyoming
August 24, 1977	Flood	EM-3052-WV	Boone, Logan, Mingo
December 14, 1978	Flood	DR-569-WV	Cabell, Jackson, Lincoln, Mingo, Wayne
August 15, 1980	Flood	DR-628-WV	Fayette, Nicholas, Raleigh, Hancock, Harrison, Jackson, Kanawha, Marion, Marshall, Monongalia, Ohio, Preston, Putnam, Taylor, Webster
May 15, 1984	Flood	DR-706-WV	Logan, McDowell, Wayne, Mingo
November 7, 1985	Flood	DR-753-WV	Barbour, Berkeley, Braxton, Calhoun, Doddridge, Gilmer, Grant, Greenbrier, Hampshire, Hardy, Harrison, Jefferson, Lewis, Marion, Mineral, Monongalia, Monroe, Morgan, Nicholas, Pendleton, Pocahontas, Preston, Randolph, Summers, Taylor, Tucker, Tyler, Upshur, Webster
June 23-28, 1995	Severe Storms, Heavy Rains, Flooding, Mudslides	DR-1060-WV	Mercer, Mineral, Nicholas
September 5-8, 1996	Hurricane Fran	DR-1137-WV	Berkeley, Grant, Hampshire, Hardy, Jefferson, Mineral, Morgan, Pendleton, Randolph, Tucker
March 7, 1997	Flood	DR-1168-WV	Braxton, Cabell, Calhoun, Clay, Gilmer, Jackson, Kanawha, Lincoln, Mason, Putnam, Roane, Tyler, Wayne, Wetzel, Wirt, Wood
June 26-July 27, 1998	Severe Storms, Flooding, and Tornadoes	DR-1229-WV	Braxton, Cabell, Calhoun, Clay, Doddridge, Gilmer, Harrison, Jackson, Kanawha, Lewis, Marion, Marshall, Ohio, Pleasants, Ritchie, Roane, Tyler, Wetzel, Wood, Wirt

Date(s) of Event	Event Type	Federal Designation	Counties Affected
May 15-September 4, 2001	Severe Storms, Flooding, and Landslides	DR-1378-WV	Boone, Cabell, Calhoun, Clay, Doddridge, Fayette, Greenbrier, Kanawha, Lincoln, Logan, Marion, Mason, McDowell, Mercer, Mingo, Nicholas, Preston, Putnam, Raleigh, Roane, Summers, Taylor, Wayne, Wyoming
May 2-20, 2002	Severe Storms, Flooding, and Landslides	DR-1410-WV	Kanawha, Logan, McDowell, Mercer, Mingo, Raleigh, Summers, Wyoming
June 11-July 15, 2003	Severe Storms, Flooding, and Landslides	DR-1474-WV	Berkeley, Boone, Cabell, Doddridge, Harrison, Kanawha, Lincoln, Logan, Marion, Mason, McDowell, Mingo, Monongalia, Nicholas, Preston, Putnam, Ritchie, Tucker, Wayne, Wyoming
September 18-30, 2003	Hurricane Isabel	DR-1496-WV	Berkeley, Grant, Hampshire, Hardy, Jefferson, Mineral, Morgan, Pendleton, Randolph, Tucker
November 11-30, 2003	Severe Storms, Flooding, and Landslides	DR-1500-WV	Barbour, Boone, Braxton, Cabell, Calhoun, Clay, Doddridge, Fayette, Gilmer, Greenbrier, Harrison, Kanawha, Lewis, Logan, Marion, Marshall, McDowell, Mercer, Monongalia, Monroe, Nicholas, Pendleton, Pocahontas, Putnam, Raleigh, Ritchie, Summers, Taylor, Upshur, Wayne, Webster, Wetzel, Wyoming
May 27-June 28, 2004	Severe Storms, Flooding, and Landslides	DR-1522-WV	Boone, Braxton, Cabell, Clay, Fayette, Gilmer, Jackson, Kanawha, Lewis, Lincoln, Logan, Mason, McDowell, Mercer, Mingo, Nicholas, Putnam, Raleigh, Roane, Wayne, Webster, Wirt, Wyoming
July 22-September 1, 2004	Severe Storms, Flooding, and Landslides	DR-1536-WV	Fayette, Lincoln, Logan, Mingo
September 16-27, 2004	Severe Storms, Flooding, and Landslides	DR-1558-WV	Berkeley, Boone, Brooke, Cabell, Clay, Hancock, Jackson, Kanawha, Lincoln, Logan, Marshall, Mason, Mingo, Morgan, Ohio, Pleasants, Putnam, Tyler, Wayne, Wetzel, Wirt, Wood
January 4-25, 2005	Severe Storms, Flooding, and Landslides	DR-1574-WV	Brooke, Hancock, Marshall, Ohio, Tyler, Wetzel
August 29-October 1, 2005	Hurricane Katrina Evacuation	EM-3221-WV	All Counties
April 14-18, 2007	Severe Storms, Flooding, Landslides, and Mudslides	DR-1696-WV	Barbour, Boone, Cabell, Gilmer, Grant, Hardy, Lewis, Lincoln, Logan, McDowell, Mingo, Pendleton, Pocahontas, Putnam, Upshur, Wayne, Webster, Wyoming
June 3-7, 2008	Severe Storms, Tornadoes, Flooding, Mudslides, and Landslides	DR-1769-WV	Barbour, Braxton, Calhoun, Clay, Doddridge, Gilmer, Harrison, Jackson, Jefferson, Lewis, Marion, Ritchie, Taylor, Tucker, Tyler, Webster, Wetzel, Wirt

Date(s) of Event	Event Type	Federal Designation	Counties Affected
May 3-June 8, 2009	Severe Storms, Flooding, Mudslides, and Landslides	DR-1838-WV	Calhoun, Gilmer, Lewis, McDowell, Mercer, Mingo, Raleigh, Roane, Upshur, Wirt, Wyoming
March 12-April 9, 2010	Severe Storms, Flooding, Mudslides, and Landslides	DR-1893-WV	Fayette, Greenbrier, Kanawha, Mercer, Raleigh, Summers
June 24, 2010	Flood	DR-1918-WV	Lewis, Logan, McDowell, Mingo, Wyoming
February 29-March 5, 2012	Severe Storms, Tornadoes, Flooding, Mudslides, and Landslides	DR-4059-WV	Doddridge, Harrison, Lincoln, Marion, Mingo, Monongalia, Preston, Ritchie, Roane, Taylor, Wayne
March 15-31, 2012	Severe Storms, Flooding, Mudslides, and Landslides	DR-4061-WV	Lincoln, Logan, Mingo
June 29-July 10, 2012	Severe Storms	EM-3345-WV	All Counties
July 26, 2013	Flood	DR-4132-WV	Mason, Roane
June 29-July 8, 2012	Severe Storms and Straight-line Winds	DR-4071-WV	Boone, Cabell, Clay, Fayette, Greenbrier, Jackson, Kanawha, Lincoln, Mason, McDowell, Mercer, Mingo, Monroe, Nicholas, Pocahontas, Raleigh, Roane, Tyler, Webster, Wood
October 29-November 8, 2012	Hurricane Sandy	EM-3358-WV	All Counties
October 29-November 8, 2012	Hurricane Sandy	DR-4093-WV	Barbour, Boone, Braxton, Clay, Fayette, Kanawha, Lewis, Nicholas, Pendleton, Pocahontas, Preston, Raleigh, Randolph, Taylor, Tucker, Upshur, Webster, Wyoming
March 3-14, 2015	Severe Winter Storm, Flooding, Landslides, and Mudslides	DR-4210-WV	Barbour, Boone, Braxton, Cabell, Doddridge, Fayette, Gilmer, Harrison, Jackson, Kanawha, Lewis, Lincoln, Logan, Marshall, McDowell, Mercer, Mingo, Monongalia, Putnam, Raleigh, Ritchie, Roane, Summers, Taylor, Tucker, Tyler, Upshur, Wayne, Webster, Wetzel, Wirt, Wood, Wyoming
April 3-5, 2015	Severe Storms, Flooding, Landslides, and Mudslides	DR-4219-WV	Boone, Cabell, Lincoln, Logan, Mingo, Wayne
May 18, 2015	Flood	DR-4220-WV	Braxton, Brooke, Doddridge, Gilmer, Jackson, Lewis, Marshall, Ohio, Pleasants, Ritchie, Tyler, Wetzel
May 21, 2015	Flood	DR-4221-WV	Cabell, Calhoun, Greenbrier, Jackson, Pleasants, Roane, Summers, Wirt
July 10-14, 2015	Severe Storms, Straight-Line Winds, Flooding, Landslides, and Mudslides	DR-4236-WV	Braxton, Clay, Jackson, Lincoln, Logan, Nicholas, Roane, Webster, Wood
June 25, 2016	Flood	DR-4273-WV	Braxton, Gilmer, Lewis, Randolph, Upshur, Wayne, Clay, Fayette, Greenbrier, Jackson, Kanawha, Lincoln, Monroe, Nicholas, Pocahontas, Roane, Summers, Webster
July 28-29, 2017	Severe Storms, Flooding, Landslides, and Mudslides	DR-4331-WV	Doddridge, Harrison, Marion, Marshall, Monongalia, Ohio, Preston, Randolph, Taylor, Tucker, Tyler, Wetzel

Date(s) of Event	Event Type	Federal Designation	Counties Affected
April 17, 2018	Mud/Landslide	DR-4359-WV	Brooke, Cabell, Calhoun, Doddridge, Hancock, Harrison, Lincoln, Logan, Marshall, Mason, Monongalia, Ohio, Pleasants, Preston, Ritchie, Taylor, Tyler, Wayne, Wetzel, Wirt, Wood
July 12, 2018	Severe Storm	DR-4378-WV	Grant, Hampshire, Hardy, Jefferson, Mineral, Morgan, Pendleton
August 2, 2019	Flood	DR-4455-WV	Grant, Pendleton, Preston, Randolph, Tucker
July 12-13, 2022	Severe Storms, Flooding, Landslides, and Mudslides	DR-4678-WV	McDowell
August 14-15, 2022	Severe Storms, Flooding, Landslides, and Mudslides	DR-4679-WV	Fayette

Source: FEMA 2023

U.S. Department of Agriculture (USDA) Disaster Declarations

The Secretary of Agriculture from the USDA is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2022, West Virginia was included in three agricultural disaster declarations pertaining to severe storms, as shown in Table 5.12-5.

Table 5.12-5. Severe Storm-Related USDA Declarations (2012 to 2022)

Date(s) of Event	Designation Number	Description of Disaster	Counties Declared
March 1-August 25, 2015	USDA-S3934	Hail, Wind, Lightning	Cabell, Hancock, Jackson, Marshall, Mason, Ohio, Pleasants, Tyler, Wayne, Wetzel, Wood
April 1-December 31, 2018	USDA-S4480	Hurricane	Braxton, Cabell, Calhoun, Clay, Doddridge, Fayette, Gilmer, Greenbrier, Jackson, Kanawha, Lewis, Mason, Nicholas, Pleasants, Pocahontas, Putnam, Randolph, Ritchie, Roane, Tyler, Upshur, Webster, Wirt, Wood
April 15, 2018-continuing	USDA-S4493	Hail	Hardy, Pendleton

Source: USDA 2022

Previous Events

Many sources provided flooding information regarding previous occurrences and losses associated with severe storm events throughout the State. The 2018 SHMP discussed specific severe storm events that occurred in the State through 2018. For this 2023 SHMP update, severe storm events were summarized between January 1, 2018, and December 31, 2022.

Table 5.12-6 includes details of severe storm events that occurred in the State between 2018 and 2022. Major events include those that resulted in losses or fatalities, as reported by the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI), events that led to a FEMA disaster declaration, and/or event that led to a USDA declaration. Due to over 2,000 events having been recorded between 2018 and 2022, the following criteria was used to narrow the events shown in Table 5.12-6:

- FEMA-declared disasters are not included in the below table and can instead be found in Table 5.12-4
- USDA-declared disaster are not included in the below table and can instead be found in Table 5.12-5
- Only events from the NOAA NCEI Storm Events Database were used in Table 5.12-6
- Events searched for in the NOAA NCEI Storm Events Database included hail, high wind, hurricane, lightning, strong wind, thunderstorm wind, tornado, and tropical storm
- Episode narratives are used for the event description
- Event narratives are not included in the event description
- Events with less than $75,000 in property and/or crop damages are not included in Table 5.12-6
- Events with a fatality are included in Table 5.12-6

Table 5.12-6. Severe Storm Events in the State of West Virginia (2018 to 2022)

Date(s) of Event	Event Type	Disaster Declaration (if applicable)	Counties Affected	Description
July 30-31, 2018	Thunderstorm Wind, Lightning	N/A	Braxton, Cabell, Calhoun, Kanawha, Putnam, Wayne	A slow-moving thunderstorm produced excessive rainfall across sections of Central West Virginia. An area of low pressure moved out of the Mississippi Valley on the 31st crossing through West Virginia that afternoon with strong to severe thunderstorms. $115,500 of property damages were incurred from this event.
September 10, 2018	Strong Wind	N/A	Monongalia	Moisture from the decaying Tropical Storm Gordon interacted with a surface low and frontal boundary, spreading widespread heavy rainfall across the region over a 3-day period. 72-hour totals across northern West Virginia ranged from 2 inches to about 5.5 inches. Small-stream flooding was not as widespread as in areas to the north and east in Pennsylvania, with only a few issues reported in Marshall County. However, winds of 30-35 mph combined with the saturated ground to cause a tree to fall on a house in Cheat Lake, killing a woman who was sleeping in an upstairs bedroom. $20,000 of property damages were incurred from this event.
October 20, 2018	Strong Wind	N/A	Boone, Cabell, Fayette, Kanawha, Lincoln, Mason, Putnam, Raleigh, Taylor, Wayne	A strong cold front brought a round of gusty winds which led to scattered tree damage and power outages. One of the hardest hit counties was Kanawha, where over 14,000 customers lost power. The ASOS at Yeager Airport measured a wind gust of 45 mph. A home along Toledo Avenue in Kanawha City has some siding blown off due to the winds, and a home in South Charleston had a punctured roof after a tree fell on it. It took nearly two days for all the power outages to be fixed. Several thousand power outages also occurred in Cabell, Logan, Lincoln, Mason, Putnam, Raleigh, and Wayne Counties. The ASOS at Raleigh County Airport measured a gust of 49 knots. AEP reported a total of 17 transmission lines were taken out in West Virginia, knocking multiple substation offline. $340,000 of property damages were incurred from this event.
February 24-25, 2019	High Wind, Strong Wind	N/A	Barbour, Berkeley, Boone, Braxton, Brooke, Calhoun, Clay, Doddridge, Fayette, Gilmer, Grant, Greenbrier, Hampshire, Hancock, Hardy, Harrison, Jackson, Jefferson,	A cold front rushed across the region during the late morning/early afternoon hours of the 24th, bringing a prolonged period of damaging wind gusts that followed the frontal passage. This resulted in an extended period of 40-60 mph wind gusts across the region. Several reports of peak gusts of 60 mph or greater were received. The highest recorded gust was 74 mph at a Mesonet sensor east of Canaan Heights in Tucker County, WV. Several peak

Date(s) of Event	Event Type	Disaster Declaration (if applicable)	Counties Affected	Description
			Kanawha, Lewis, Lincoln, Logan, Marshall, Mason, McDowell, Mercer, Mineral, Mingo, Monongalia, Monroe, Morgan, Nicholas, Ohio, Pendleton, Pleasants, Pocahontas, Preston, Putnam, Raleigh, Randolph, Ritchie, Roane, Summers, Taylor, Tucker, Tyler, Upshur, Wayne, Webster, Wetzel, Wirt, Wood, Wyoming	wind gusts in excess of 60 mph were observed as well. There were widespread reports of downed trees, power lines, and structural damage across the entire region, with some examples noted in the county entries. Thankfully, no injuries were reported from wind effects. Power outages were widespread as well. A peak of 91,000 outages were recorded in West Virginia on the night of the 24th. Full restoration took multiple days due to the extent of damage and the initially unsafe working conditions due to the ongoing wind. $1,920,500 of property damages were incurred from this event.
April 14, 2019	Thunderstorm Wind, Hail	N/A	Barbour, Boone, Braxton, Cabell, Clay, Fayette, Greenbrier, Harrison, Kanawha, Lewis, McDowell, Ohio, Pocahontas, Preston, Raleigh, Randolph, Summers, Upshur	For this event, the tornado risk was perceived to be relatively high, with the Storm Prediction Center forecasting numeric probabilities in the vicinity of the Ohio River that were of an unusually high level. No tornado activity was confirmed in West Virginia from this event, with only a few severe weather reports received overall. $122,000 of property damages were incurred from this event.
May 2-3, 2019	Thunderstorm Wind, Hail	N/A	Berkeley, Cabell, Calhoun, Kanawha, Putnam	A very localized microburst in Kanawha County resulted in $743,000 of property damages.
May 23, 2019	Thunderstorm Wind, Hail	N/A	Clay, Fayette, Jackson, Kanawha, Marion, Mason, Nicholas, Preston, Roane	Thunderstorms developed in the middle Ohio River Valley on the afternoon of the 23rd. These storms quickly grew to severe levels, producing very large hail and sporadic wind damage as they moved across Central West Virginia. $765,000 of property damages were incurred from this event.
May 25-26, 2019	Thunderstorm Wind, Lightning	N/A	Gilmer, Harrison, Jackson, Logan, Mason, Mercer, Monongalia, Ritchie, Roane, Taylor, Tyler, Webster, Wirt, Wood, Wyoming	Thunderstorms produced minor flash flooding, along with wind damage and some hail. Lightning is believed to be the cause of a fire at a natural gas condensate storage tank owned by Dominion Energy Transmission, Inc. The million-gallon tank was holding roughly 640,000 gallons of fuel and took about 12 hours to extinguish. The community of Bens Run was evacuated for a time due to concerns of explosion. $1,152,000 of property damages were incurred from this event.

Date(s) of Event	Event Type	Disaster Declaration (if applicable)	Counties Affected	Description
May 29, 2019	Thunderstorm Wind, Hail	N/A	Brooke, Fayette, Greenbrier, Jackson, Logan, Mason, McDowell, Mercer, Mingo, Monongalia, Monroe, Raleigh, Roane, Summers, Webster, Wirt, Wood, Wyoming	Storms produced hail up to the size of quarters and produced damaging winds that blew down numerous trees and power lines. The trees also damaged several structures. $437,500 of property damages were incurred from this event.
June 24, 2019	Thunderstorm Wind, Hail, Lightning, Tornado	N/A	Barbour, Braxton, Brooke, Cabell, Clay, Greenbrier, Hancock, Kanawha, Lewis, Mercer, Mingo, Putnam, Randolph, Upshur, Wayne, Wetzel	A line of severe thunderstorms stretched across Central Appalachia on June 24th, resulting in widespread wind damage as well as two tornadoes touching down near the City of Charleston. Lightning struck a tree, which then fell on top of a house. A limb from the tree injured one person as it fell. $693,400 of property damages were incurred from this event.
October 31, 2019	Thunderstorm Wind, Strong Wind, High Wind	N/A	Boone, Braxton, Fayette, Grant, Kanawha, Logan, Mingo, Monroe, Morgan, Ohio, Pocahontas, Tucker, Wyoming	A cold front led to a period of high winds across the region. Many gusts of 45 to 50 mph were observed, with a high gust of 64 mph reported in eastern Tucker County, WV. Many reports of tree and power line damage were received, and power outages numbered into the thousands of customers. Wind impacts were likely more widespread than reported. $79,000 of property damages were incurred from this event.
November 27, 2019	Strong Wind, High Wind	N/A	Berkeley, Cabell, Fayette, Grant, Greenbrier, Hampshire, Hardy, Jackson, Kanawha, Mason, Mercer, Mineral, Monroe, Morgan, Pendleton, Pocahontas, Preston, Putnam, Raleigh, Randolph, Roane, Summers, Tucker, Wayne	A cold front resulted in widespread wind gusts of 40 to 50 mph. The highest measured gust was near Snowshoe in Pocahontas County, where a Mesonet station measured at 67 mph gust. Most damage was limited to trees and power lines; however, a column at the front of the Westmoreland Baptist Church in Huntington was toppled by the wind. $691,000 of property damages were incurred from this event.
January 11-12, 2020	Strong Wind, Thunderstorm Wind, High Wind	N/A	Barbour, Braxton, Cabell, Calhoun, Clay, Doddridge, Fayette, Gilmer, Harrison, Jackson, Kanawha, Lewis, Lincoln, Logan, Marion, Mason, McDowell, Mingo,	A strong storm system moved through the Great Lakes on the 11th and 12th. Gusts ahead of this system were regularly measured in the 40-50 mph range. A line of showers and thunderstorms developed in the lower Ohio River Valley along a cold front and quickly raced eastward through the late afternoon and evening. By the time these got to the middle Ohio River Valley and central Appalachians, no lightning was present, but the convective

Date(s) of Event	Event Type	Disaster Declaration (if applicable)	Counties Affected	Description
			Nicholas, Pleasants, Pocahontas, Putnam, Raleigh, Randolph, Ritchie, Roane, Taylor, Tyler, Upshur, Wayne, Webster, Wirt, Wood, Wyoming	showers were still packing gusty outflow winds, with lots of tree and utility damage reported. The actual cold front surged through late that night, with another round of 45-55 mph winds, causing more power outages. Shortly after noon on the 11th, a tree fell onto a side-by-side ATV near Ashford in Boone County. A 14-year-old boy was fatally wounded, and his father and sister were injured. The ASOS at Charleston's Yeager Airport, which is about 13 miles from the incident site, measured gusts of 30-40 mph around the time of the incident. These were driven by the synoptic flow, not convective activity. $511,000 of property damages were incurred from this event.
April 7-13, 2020	Strong Wind, Thunderstorm Wind, High Wind, Hail	N/A	Berkeley, Boone, Braxton, Cabell, Clay, Doddridge, Fayette, Gilmer, Hardy, Harrison, Jefferson, Kanawha, Lewis, Lincoln, Logan, Marshall, Mason, McDowell, Mercer, Mingo, Monongalia, Monroe, Nicholas, Pocahontas, Putnam, Raleigh, Randolph, Ritchie, Roane, Tucker, Tyler, Upshur, Upshur, Wayne, Webster, Wood	A strong low-pressure system crossing through the state inflicted multiple rounds of severe weather across West Virginia. Starting on the 7th, a warm front draped across the Ohio Valley was the primary focus for convection to develop that evening. These storms produced large hail across portions of northern West Virginia. A brief lull in storms during the day of the 8th primed the atmosphere once more for severe thunderstorms to arise ahead of a cold front which passed through late that night. During which time, another round of thunderstorm wind damage, hail, and flash flooding occurred late that evening and into the early morning hours of the 9th. Local cooperative observers reported 1 to 2 inches of rainfall occurred with this second round of convection. Strong synoptic winds of 35-45 mph on the backside of the disturbance remained in place before high pressure finally built into the region. An intense low-pressure system crossed into the Ohio Valley during the early morning hours on the 13th, with a strong line of thunderstorms aligned along a surface cold front. Multiple areas saw tree and structural damage with these storms. A tightened pressure gradient formed over the state, inflicting strong synoptic winds outside of the thunderstorms. Numerous trees were blown down, knocking power out to multiple areas. Near Mt. Hope in NW Fayette County, a 50-foot section of brick wall collapsed at the municipal stadium. Other buildings sustained roof damage around Mt. Hope. Nearby, the Beckley ASOS gusted to 53 mph. Many personal and DOT weather stations measured gusts around 50 mph across the region. $1,478,000 of property damages were incurred from this event.

Date(s) of Event	Event Type	Disaster Declaration (if applicable)	Counties Affected	Description
April 21, 2020	Strong Wind	N/A	Barbour, Harrison, Kanawha, Logan, Raleigh, Randolph, Tyler, Upshur, Wayne, Wood	In the wake of a frontal passage, strong synoptic winds prevailed on the afternoon of the 21st into the evening before tapering down. Widespread wind gusts of 40 to 50 mph were measured in the state. The highest gust was at Yeager airport in Kanawha County where the ASOS measured a 56-mph gust. Isolated power outages were caused by fallen trees and limbs. $90,000 of property damages were incurred from this event.
July 6-7, 2020	Thunderstorm Wind, Hail	N/A	Grant, Greenbrier, Harrison, Jefferson, Kanawha, Mineral, Mingo, Taylor	An upper-level disturbance triggered numerous showers and thunderstorms. The very unstable lower-level air mass resulted in an environment conducive to downburst winds, some of which were significant. Diurnally driven showers and storms formed each day, with some of the storms producing hail and strong winds, along with heavy rainfall. $88,500 of property damages were incurred from this event.
August 1, 2020	Thunderstorm Wind	N/A	Calhoun, Harrison, Kanawha, Lincoln, Morgan, Raleigh, Roane	A warm front pushed through the central Appalachians and middle Ohio River Valley, kicking off strong to severe thunderstorms in the afternoon and early evening. $137,000 of property damages were incurred from this event.
August 25, 2020	Thunderstorm Wind, Hail	N/A	Barbour, Boone, Cabell, Clay, Fayette, Grant, Greenbrier, Hampshire, Harrison, Jackson, Kanawha, Marion, Marshall, Mason, Mineral, Monongalia, Morgan, Preston, Putnam, Ritchie, Roane, Taylor, Upshur, Wetzel, Wirt, Wyoming	Severe storms were able to take advantage of a frontal boundary sagging towards I-70. Shear and increasing instability favored multi-cells and short bowing segments initially. Damage in northern West Virginia was mainly limited to trees and power lines from the thunderstorm wind, although one instance of roof damage was reported. Also, an instance of large hail was observed in Preston County. $322,500 of property damages were incurred from this event.
November 15, 2020	Thunderstorm Wind	N/A	Berkeley, Brooke, Hancock, Hardy, Jefferson, Lewis, Mineral, Monongalia, Morgan, Ohio, Preston, Tucker	A cold front brought strong winds to the region. Widespread wind gusts of at least 45-55 mph were observed, with several higher measured gusts seen. Along the convective line, gusts of 55-65 mph likely occurred. This resulted in widespread reports of wind damage to trees and power lines, with a few instances of mostly minor structural damage. $173,000 of property damages were incurred from this event.
May 3-4, 2021	Thunderstorm Wind, Tornado	N/A	Berkeley, Jefferson, Marion	An isolated, cyclic supercell thunderstorm tracking along a warm front produced sporadic straight-line wind damage and spawned several tornadoes. $118,000 of property damages were incurred from this event.

Date(s) of Event	Event Type	Disaster Declaration (if applicable)	Counties Affected	Description
June 13-14, 2021	Thunderstorm Wind, Tornado, Hail	N/A	Barbour, Boone, Brooke, Calhoun, Clay, Doddridge, Fayette, Gilmer, Grant, Greenbrier, Hardy, Harrison, Kanawha, Lewis, Lincoln, Marion, Marshall, Monongalia, Monroe, Nicholas, Ohio, Pleasants, Preston, Putnam, Raleigh, Ritchie, Taylor, Tyler, Upshur, Webster, Wetzel, Wood	A strong cold front in accordance with a passing low-pressure system pressed into West Virginia on the evening of June 13th. Strong to severe thunderstorms accompanied the front, resulting in multiple instances of downed trees and power lines due to damaging wind gusts. Due to the combination of heavy downpours and multiple storms passing over the area that day, several counties observed flash flooding. The most notable events occurred in Gilmer County, where a large shed on a golf course was swept away by the rushing high water, and Pocahontas County, where a swift water rescue was conducted in the town of Frost. An isolated supercell developed ahead of an advancing boundary and quickly spun up a tornado near Pleasant Valley, WV. $261,000 of property damages were incurred from this event.
June 21, 2021	Thunderstorm Wind	N/A	Barbour, Berkeley, Brooke, Doddridge, Gilmer, Hampshire, Hancock, Harrison, Jefferson, Kanawha, Lewis, Lincoln, Logan, Marion, Mineral, Monongalia, Nicholas, Preston, Putnam, Ritchie, Taylor, Tyler, Upshur, Wirt, Wood, Wyoming	Thunderstorms flourished across West Virginia on the afternoon and evening of June 21st as a cold front glided through the region. Many of these storms became severe and caused damaging winds to knock down trees ahead of the front's passage. Early in the afternoon, a Mesonet station in Ritchie County measured a 52 mile per hour wind gust as the first round of thunderstorms propagated eastward. Later that evening, a second burst of storms arrived, with a 48 mile per hour wind gust being measured at the Clarksburg airport. With saturated grounds already present ahead of these storms, an instance of flash flooding was observed in Wood County, where several roads became impassible for a brief period. $169,000 of property damages were incurred from this event.
July 29, 2021	Thunderstorm Wind	N/A	Monongalia, Ohio, Preston, Tucker	A shortwave passage during the morning of July 29th spread mainly non-severe showers and thunderstorms across the region during the morning and midday hours. However, a discrete cell along the back edge of the morning activity was able to develop a tornado along the Fayette-Westmoreland County border in Pennsylvania. This was a preview of what was to follow. In the wake of this morning activity, additional thunderstorms were able to develop. A cross-boundary component to this shear allowed discrete supercells to form during the mid and late afternoon hours. Storm motions were favorable for the ingestion of streamwise vorticity, allowing for rotating storms. While eight tornadoes formed during this event across eastern Ohio and southwest Pennsylvania, the severe events in West Virginia

Date(s) of Event	Event Type	Disaster Declaration (if applicable)	Counties Affected	Description
				were limited to straight-line wind damage to mainly trees. Training thunderstorms also led to reports of numerous flooded roads in Monongalia County. $107,000 of property damages were incurred from this event.
August 13, 2021	Thunderstorm Wind	N/A	Boone, Clay, Hancock, Hardy, Jefferson, Kanawha, Lincoln, Pendleton, Summers, Wayne	Thunderstorms developed across West Virginia on August 13th. Multiple trees and power lines were blown down that afternoon with substantial damage observed near Wallace in Kanawha County as a tree fell onto a trailer and a car. Minor flooding was also observed near the Town of Danville. $173,500 of property damages were incurred from this event.
May 1, 2022	Thunderstorm Wind, Hail	N/A	Clay, Monongalia	Showers and thunderstorms, mainly in broken lines, accompanied a cold front across the region during the afternoon and evening hours of May 1st. Moderate shear and instability, as well as mid-level dry air, led to the development of several instances of severe thunderstorms, with damaging wind gusts being the primary impact. One storm grew strong enough to produce half-dollar-sized hail in Clay County. $197,000 of property damages were incurred from this event.
May 3, 2022	Thunder Storm Wind	N/A	Grant, Hampshire, Hardy, Harrison, Monongalia, Ohio, Taylor, Wood	Numerous thunderstorms impacted the region during the afternoon and evening hours of May 3rd. Several wind damage reports were received in northern West Virginia. Although a tornado watch was issued, and one funnel cloud was spotted, no tornadoes were reported in the region. $116,000 of property damages were incurred from this event.
June 8, 2022	Thunderstorm Wind, Hail	N/A	Greenbrier, Hampshire, Harrison, Jackson, Kanawha, Lewis, Marion, Marshall, Mason, Mineral, Monongalia, Monroe, Morgan, Preston, Putnam, Randolph, Taylor, Tyler, Wetzel, Wood	Storms that produced large hail and high winds developed across the Ohio River Valley on the evening of June 8th. Numerous supercell storms formed hours before reaching eastern Ohio along an advancing warm front; the main threat occurred between 6pm and 10pm. The vicinity of the strongest storms was south of I-70 where the moisture boundary resided. Mid-level dry and strong deep wind shear helped the development of unusually large hail (up to 2 inches). $132,750 of property damages and $6,000 in crop damages were incurred from this event.
June 13-14, 2022	Thunderstorm Wind	N/A	Boone, Cabell, Clay, Doddridge, Fayette, Greenbrier, Harrison, Jackson, Kanawha, Lewis, Lincoln, Logan, Mason, Mercer, Ohio, Putnam,	A line of thunderstorms crossed through the Ohio Valley during the late afternoon of June 13th, moving into West Virginia in the evening hours. Hot temperatures during the day aided with providing afternoon heating for storms to thrive. Damaging winds were the main concern with this line of storms as it persisted across the Ohio Valley; however, frequent lightning also accompanied these storms. As this first line was exiting along southern

Date(s) of Event	Event Type	Disaster Declaration (if applicable)	Counties Affected	Description
			Raleigh, Upshur, Wayne, Wirt, Wood, Wyoming	West Virginia, a second line of storms formed along the lingering frontal boundary and pushed into the northern portion of the region during the night of the 13th. Damaging winds were the main threat with this secondary line of storms. Following this line, another round of storms with damaging winds entered along the northwestern portions of the area during the early morning of June 14th as enough instability continued to be present across the area. A fourth line passed through by the later morning hours of the 14th. The main impacts from these storms were the numerous trees and power lines that were blown down across the region. Multiple power outages occurred across West Virginia as a result. Following the multiple rounds of storms, rises occurred on a few rivers across the forecast area. Isolated high water issues occurred along local roadways in Randolph and Harrison Counties, with a few roads becoming impassable for a brief period. $95,500 of property damages were incurred from this event.
June 16-17, 2022	Thunderstorm Wind, Hail	N/A	Gilmer, Greenbrier, Jefferson, Kanawha, Lewis, Logan, Mercer, Monroe, Nicholas, Pleasants, Pocahontas, Putnam, Ritchies, Roane, Summers, Tyler, Upshur, Wayne	On June 16th, the strongest storms resided across the northern portions of West Virginia, where numerous trees were blown down, and quarter-sized hail fell. A few instances of heavy downpours within the storms occurred, leading to high water along local roadways in Tyler and Gilmer Counties. On June 17th, numerous trees were blown down across the central portions of West Virginia from strong wind gusts in the early afternoon, followed by more trees down in the southeastern portions of the state a few hours later. The most significant damage caused by these storms was a roof being blown off a home in Lincoln County. Heavy downpours and antecedent wet ground conditions also resulted in one instance of flash flooding along sections of Route 129 and 39 in the town of Poe. $171,750 of property damages were incurred from this event.
July 12, 2022	Thunderstorm Wind, Hail, Tornado, Lightning	N/A	Fayette, Grant, Greenbrier, Hampshire, Hardy, Harrison, Kanawha, Logan, Mason, Mineral, Pocahontas, Preston, Putnam, Raleigh, Summers, Taylor, Tucker	An outbreak of significant severe weather occurred during the afternoon and evening hours of Tuesday, July 12th, 2022. Swaths of widespread damaging winds were observed, much of which was considerable. A couple of tornadoes were also confirmed, along with some significant hail. A wind gust of over 100 mph was measured in one of the most powerful storms over eastern West Virginia. $1,426,250 of property damages and $150,000 in crop damages were incurred from this event.

Date(s) of Event	Event Type	Disaster Declaration (if applicable)	Counties Affected	Description
July 23-24, 2022	Thunderstorm Wind, Hail	N/A	Doddridge, Grant, Greenbrier, Hancock, Hardy, Harrison, Jackson, Lewis, Mason, Mineral, Morgan, Nicholas, Ohio, Ohio, Pendleton, Pocahontas, Preston, Roane, Taylor, Tyler, Upshur, Webster, Wetzel	A widespread wind damage event occurred on July 23rd. The line of storms crossed northern West Virginia during the early to middle afternoon hours. Although damage was more widespread to the north, several instances of wind damage to trees and power lines resulted from the storms. High levels of instability, ample shear, and pre-frontal disturbances provided thunderstorm clusters producing widespread damaging wind gusts, nearly all of which occurred further north, but one instance of wind damage was reported in Ohio County. $171,750 of property damages were incurred from this event.
August 1, 2022	Thunderstorm Wind, Tornado	N/A	Braxton, Marshall	Low pressure drew in a cold front on the afternoon of August 1st contributing to the development of scattered showers and thunderstorms. Antecedent rainfall ahead of this event resulted in susceptible soil conditions, which coupled with heavy rainfall led to areas of flash flooding. Two tornadoes spun up from a single supercell. $600,000 of property damages and $5,000 in crop damages were incurred from this event.

Sources: NOAA NCEI 2023; FEMA 2023

Probability of Future Hazard Events

Overall Probability

According to FEMA's disaster declaration, the USDA disaster declarations, the NOAA NCEI Storm Events Database, and the 2018 SHMP, the State experienced over 9,000 events between 1996 and 2022, as summarized in Table 5.12-7.

Table 5.12-7: Probability of Future Severe Storm Events in West Virginia

Hazard Type	Number of Occurrences Between 1996 and 2022	Percent Chance of Occurrence in Any Given Year
High Wind / Strong Wind	1,254	100
Lightning	90	100
Thunderstorm Wind	5,520	100
Hail	2,416	100
Tornado	79	100
Hurricane and Tropical Storm	0	0
Total	**9,359**	**100**

Sources: FEMA 2023; USDA 2023; NOAA NCEI 2023

Projected Future Conditions

Future conditions have the potential to make storms such as thunderstorms, hurricanes, and tornadoes more severe. Tornado activity in the United States has become more variable, particularly over the 2000s, with a decrease in the number of days per year with tornadoes and an increase in the number of tornadoes on particular days (U.S. Global Change Research Program 2018). West Virginia historically averages only two to five tornadoes per year, but any increase in that number could have severe impacts upon life safety and property, particularly in the State's poorer areas.

Although West Virginia is not a coastal state, it is not immune from the impacts of coastal storms. As these storms are projected to intensify in frequency and extent, it is safe to assume that hurricane-related winds will increase in West Virginia. In West Virginia, an increase in both the number and intensity of severe storms could have devastating impact upon public utilities such as power grids, internet, and stormwater/wastewater systems. See the Utility Failure section below for further detail (U.S. Global Change Research Program n.d.) (NOAA 2022) (MetroNews 2021).

5.12.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable in the identified hazard area. For severe storms, the entirety of West Virginia has been identified as the hazard area. Therefore, all assets in the State (population, structures, critical facilities, and lifelines), as described in the State Profile, are vulnerable. The impacts on population, existing structures, critical facilities, and the economy are presented below.

State Assets

For the purposes of this risk assessment, an asset is considered potentially vulnerable if it is in an identified hazard area. As stated previously, for the severe storm hazard the entire area of West Virginia is the hazard area. Therefore, all State facilities and State roadways are vulnerable to severe storms.

Critical Facilities and Community Lifelines

Overall, all critical facilities are exposed to severe storm events. Transportation routes are vulnerable to severe storms and have the potential to be wiped out or blocked, creating isolation issues from responders. This includes all roads and bridges in the path of a severe storm event. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand high wind speeds and excessive precipitation. Utility infrastructure is also vulnerable; interruption of services may not only impact vulnerable populations but may also impact critical facilities that need to be in operation during a disaster. Because power interruption can occur, backup power is recommended for critical facilities and infrastructure. Full functionality of critical facilities such as police, fire, and medical services is essential for response during and after a severe storm event.

Table 5.12-8 summarizes wind impacts on critical facilities. Overall, the 1,000 year mean return period hurricane event is only expected to result in one lost school day and fairly minor to low-end moderate probabilities of sustaining damages.

Table 5.12-8. 1,000 Year Mean Return Period Hurricane Wind Impacts on Critical Facilities

Facility Type	1000-Year Mean Return Period Hurricane				
	Loss of Days	Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
Medical Care Facilities	0	0% - 2.3%	0% - 0.2%	0.00%	0.00%
Police Stations	0	0% - 10.6%	0% - 3%	0% - 0.2%	0.00%
Schools	1	0% - 10%	0% - 9.3%	<0.1%	0.00%
Other	N/A	0.0% - 12.7%	0% - 4.1%	0.0% - 0.5%	0.00%

Source: Hazus 6.0

Population

For the purpose of this SHMP, the entire population of West Virginia (1,807,426) is exposed to the severe storm hazard. Residents may be displaced or require temporary and long-term housing and sheltering. In addition, damages caused by severe storms can lead to severe injuries and loss of life.

Impacts on Socially Vulnerable Populations

Socially vulnerable populations are most susceptible due to their physical and financial ability to react and respond during extreme severe storms. This population includes the elderly, young, and individuals with disabilities or access or functional needs who may be unable to evacuate in the event of an emergency. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that might not be readily available due to isolation during a storm event. Section 2 (State Profile) provides statistics of these populations. The vulnerable population also includes those who would not have adequate warning from an emergency warning system (e.g., television or radio); this would include residents and visitors. The population adversely affected by severe storms may also include those beyond the disaster area that rely on affected roads for transportation.

Economically disadvantaged people are at high risk for bracing severe storms because of the potential inability to afford up-to-code homes and buildings that are deemed safe from storms passing through. They also may pose health issues, such as exposure to mold and other health issues that water seepage may cause. These populations may also lack access to vehicles for any necessary evacuations.

Future Changes That May Impact State Vulnerability

Understanding future changes that may impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors in examining potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including impacts of future conditions

Potential or Projected Development

Although West Virginia has not experienced significant growth, any areas of growth could be impacted by the severe storm hazard because the entire State is exposed and vulnerable. However, due to increased standards and codes, new development may be less vulnerable to the hazard, while aging infrastructure will become increasingly vulnerable.

Projected Changes in Population

West Virginia is losing population faster than recent forecasts, which do not account for county-by-county increases. According to population projections in 2022 from the West Virginia University (WVU) Bureau of Business and Economic Research, West Virginia's population was projected to fall from 1,793,716 in 2020 to 1,705,509 in 2040 (West Virginia University 2022). As of July 1, 2019, according to estimates by the U.S. Census Bureau, West Virginia's total population is 1,792,147, representing a 3.3 percent decline since 2010 (approximately 60,487 fewer residents). West Virginia lost population both naturally, with 19,000 more deaths than births, and through migration, with 27,000 more people leaving the State than moving in (WVDOT 2020). Refer to Section 2 (State Profile), which includes a discussion on population trends for the State.

As population in the State continues to decrease, there is the potential that fewer people will reside or work within the State's severe storm area. Increased abandoned properties that will be more vulnerable to the elements are more likely to occur within a declining population. Additionally, as the population in the State ages, more residents may face challenges quickly evacuating an area in the event of an intense hazard event.

Other Factors of Change

As the world warms, the frequency and severity of these events are likely to increase due to increasing evaporation and higher atmospheric water vapor levels in the atmosphere. It is anticipated by scientists that the intensity of hurricanes, tropical storms, and other coastal storms will increase. However, since tornadoes and severe thunderstorms occur over much shorter timeframes and smaller areas, the trends and future projections and trends are more difficult to predict. Compared to damages from other types of extreme weather, those occurring due to thunderstorm-related weather hazards have increased the most since 1980, and there is some indication that, in a warmer world, the number of days with conditions conducive to severe thunderstorm activity is likely to increase (CSSR 2018).

5.12.3 Consequence Analysis

Impacts to the Public

Severe weather impacts will impact some communities harder than others. Phenomena like tornadoes, hailstorms, and severe storms can cause damage to property, leaving low-income individuals with few options to repair their properties. In addition, impoverished and homeless populations are more vulnerable than others to severe storms due to potential lack of shelter, or building materials that are not made to withstand severe storms. In some cases, severe storms can trap people from downed powerlines, flooding, and fallen trees. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. This endangers those that may need assistance evacuating, as well as those that need to call for help when injured. Some severe events may call for shutting down air and rail transportation which could disrupt medical and emergency services as well as the transportation of emergency supplies, endangering those that are in need of help even more.

People who spend a lot of time outside, such as agricultural workers and the unhoused, are vulnerable to exposure and injury from events like severe storms, hailstorms, and/or tornadoes. Some weather has the ability to damage or destroy agricultural fields, which can affect livelihoods of the people that depend on the fields for economic purposes.

Impacts to Responders

Intense storms can immobilize a region and paralyze a city by shutting down air and rail transportation, stopping flow of supplies, and disrupting medical and emergency services. Lack of power to emergency facilities, such as police stations, fire stations, emergency medical services, and hospitals, will inhibit a community’s ability to effectively respond to an event and maintain the safety of its citizens. Speed of wind and accumulations of rain can collapse buildings and knock down trees, communication, and power lines, making it difficult for responders to be able to pinpoint who needs help and where they may be. In rural areas, homes and farms may be isolated for days, due to communication failure and impassable roads.

Impacts to Continuity of Operations

Heavy winds can bring down trees, electrical wires, telephone poles and lines, and communication towers. This can impact continuity of operations statewide and can also affect neighboring states due to supply chain shortages. Severe storms can obstruct and slow transportation from knocked down trees and utility lines which causes structural collapse in buildings not designed to withstand intense wind and rain events. Strong tornadoes and hurricanes impact airports and roadways, sometimes even closing them completely, which stops the flow of supplies and disrupting emergency and medical services. The flooding and high winds associated with severe storms may also disrupt the distribution of gasoline, kerosene, diesel fuel, fuel oils, propane, and other petroleum products. This disruption could cause major problems for organizations and businesses that rely on such supplies. Additionally, such a disruption could affect backup power generation.

Impacts to Property, Facilities, and Infrastructure

Severe storms can damage and destroy infrastructure through wind speeds, hail size, flooding, etc., making the facility or infrastructure unsafe or impractical to use. Even well-constructed buildings are vulnerable to the effects of a stronger (generally EF-2 or higher) tornado. Due to the relatively low incidence and risk for tornado, traditional “Tornado Alley” mitigation methods such as tornado-safe rooms may not be economically feasible in West Virginia.

Utility infrastructure could suffer damage from high winds associated with falling tree limbs or other debris, resulting in the loss of power. Loss of service can impact residents and business operations alike. Interruptions in heating or cooling utilities can affect populations such as the young and elderly, who are particularly vulnerable to temperature-related health impacts. 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 due to pump failure until power is restored.

Impacts to the Environment

Environmental resources, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands, parks, and reserves are particularly vulnerable to severe storms. Destroyed habitats could displace and kill organisms reliant on these habitats. The impacts of intense windstorms and precipitation on the environment typically take place over a larger area. Where these events occur, widespread, severe damage to 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.

Impacts to the Economic Condition of the State

Potential economic impacts include loss of agriculture, business, and tourism. In addition, losses of buildings and infrastructure also take a toll on the economic condition of West Virginia. Similarly, damages to buildings can displace people from their homes, threaten life safety and impact a community’s economy and tax base. Severe storms can also damage utilities and communication towers, which are costly because they need to be repaired almost immediately after damages occur, and these repairs can cost millions of dollars to fix for a singular event.

Infrastructure at risk from severe storms also include roadways that could be damaged by tornadoes, hail, and increased precipitation. Costs to repair roads from severe storm impacts can drain local financial resources quickly. A quick thunderstorm or prolonged hurricane event can cause substantial flooding, especially along small streams and in urban areas, which can become expensive to mitigate. Potential secondary impacts from severe storms also impact the local economy, including the interruption of transportation corridors and loss of business function for the duration of the event. Finally, extensive damage to forests can affect timber values and create flammable woody debris, exacerbating wildfire vulnerability.

IMPACTS TO PUBLIC CONFIDENCE IN STATE GOVERNANCE

The public confidence in state governance primarily depends on how effective the State has been in the past at preparing for and responding to sever storm events. Public confidence also depends on the size of the event and the preparation the State takes for each potential event. In general, if the State is transparent in sharing relevant information with the public regarding sever storm events, then the public is more apt to trust the State and feel as if it has the capability to support the residents of West Virginia if a severe storm event occurs. The State also demonstrates its reliability to the public through availability of programs and services relevant to severe storm assistance (Chew, et al. 2021).