

SECTION 4. RISK ASSESSMENT

4.3 Hazards of Concern

This section provides a profile and vulnerability assessment of the severe summer weather hazard in Camden County. See Section 4.3.9 (High Wind) for additional storm-related hazard events.

2022 HMP Changes

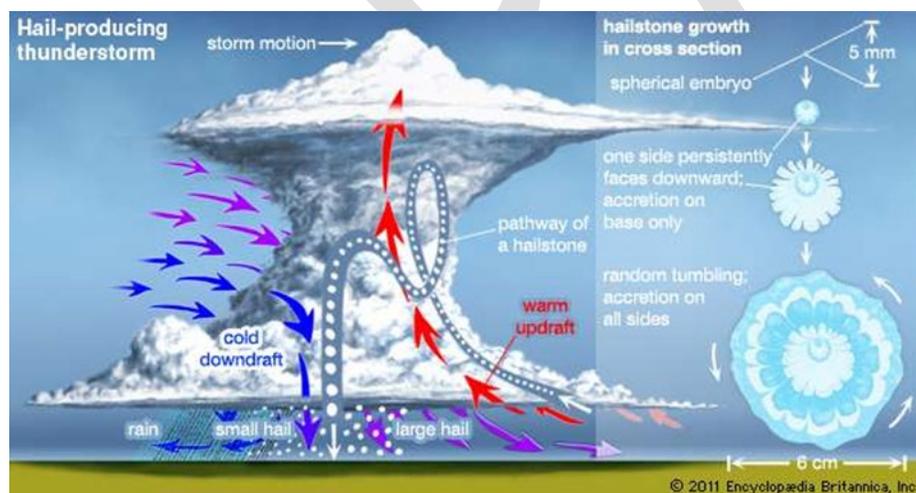
- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2015 and 2020.

4.3.11 Severe Summer Weather

Hailstorms

Hail forms inside a thunderstorm or other storms with strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32 degrees Fahrenheit (°F) or colder. As the frozen droplet begins to fall, it may thaw as it moves into warmer air toward the bottom of the thunderstorm. However, the droplet may be picked up again by another updraft and carried back into the cold air and re-freeze. With each trip above and below the freezing level, the frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail. Most hail is small and typically less than (2 inches in diameter (NWS 2010). Figure 4.3.11-1 shows how hail is formed within thunderstorms.

Figure 4.3.11-1. Hail Formation in Thunderstorms



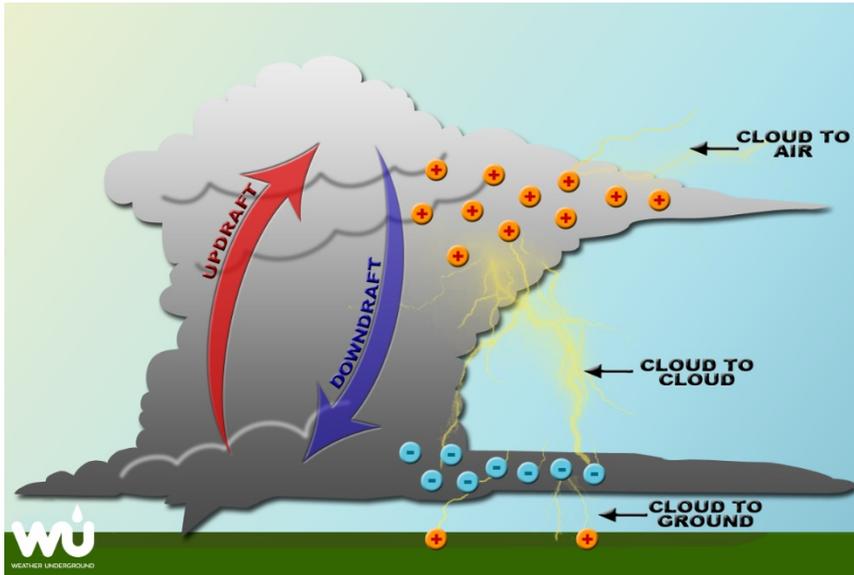
Source: Encyclopedia Britannica 2011

Lightning

Lightning is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. Lightning ranks as one of the top weather

killers in the United States, killing approximately 50 people and injuring hundreds each year. Lightning can occur anywhere there is a thunderstorm. Lightning can be cloud to air, cloud to cloud, and cloud to ground. Figure 4.3.11-2 demonstrates the variety of lightning types.

Figure 4.3.11-2. Types of Lightning



Source: Weather Underground date unknown

4.3.11.1 Location and Extent

All of Camden County is exposed to severe summer weather. The extent (severity or magnitude) of a severe weather event is largely dependent upon the most damaging aspects of each type of severe weather.

Table 4.3.11-1. Extent of Severe Storms in Camden County

Extent of Severe Storms in Camden County	
Largest Hailstone on Record	3.0 inches

Source: NOAA 2021

4.3.11.2 Range of Magnitude

Hailstorms

The severity of a hailstorm is measured by duration, hail size, and geographic extent. Most hail stones from hailstorms are made up of variety of sizes. The size of hail is estimated by comparing it to a known object. Table 4.3.11-2 describes the different sizes of hail as compared to real-world objects and lists approximate measurements.

Table 4.3.11-2. Hail Size

Size	Inches in Diameter
Pea	0.25 inch
Marble/mothball	0.50 inch
Dime/Penny	0.75 inch
Nickel	0.875 inch
Quarter	1.0 inch
Ping-Pong Ball	1.5 inches
Golf Ball	1.75 inches
Tennis Ball	2.5 inches
Baseball	2.75 inches
Tea Cup	3.0 inches
Grapefruit	4.0 inches
Softball	4.5 inches

Source: NOAA 2012

Lightning

Lightning is most often associated with moderate to severe thunderstorms. The severity of lightning refers to the frequency of lightning strikes during a storm. Multiple devices are available to track and monitor the frequency of lightning. See Section 4.3.9 (High Wind) for more information about severe thunderstorms that often accompany lightning events.

4.3.11.3 Past Occurrence

Table 4.3.11-3 summarizes historical severe summer weather events from 1950 to 2020 in Camden County based on data collected from the NOAA NCDC, USDA and FEMA disaster declaration databases.

Table 4.3.11-3. Severe Summer Weather Events in Camden County, 1950 to 2020

Hazard Type	Number of Occurrences Between 1950 and 2019	Total Fatalities	Total Injuries	Total Property Damage (\$)	Total Crop Damage (\$)
Hail	53	0	0	\$0	\$1.5 Million
Lightning	15	0	4	\$291,000	\$0
Total	68	0	4	\$291,000	\$1.5 Million

Source: NOAA-NCDC 2020

Between 1954 and 2020, FEMA included New Jersey in 38 severe storm-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe

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storms, flooding, and hurricane. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Camden County has been included in 8 declarations for severe summer storm-related events (FEMA 2019). Table 4.3.11-4 lists these events.

Table 4.3.11-4. Severe Summer Storm-Related FEMA Disaster Declarations for Camden County

Declaration	Event Date	Declaration Date	Event Description
DR-310	September 4, 1971	September 4, 1971	Heavy Rains, Flooding
EM-3148	September 16 – 18, 1999	September 17, 1999	Hurricane Floyd
DR-1530	July 12 – 23, 2004	July 16, 2004	Severe Storms and Flooding
DR-1694	April 14 – 20, 2007	April 26, 2007	Severe Storms and Inland and Coastal Flooding
EM-3332 DR-4021	August 26 – September 5, 2011	August 27, 2011 August 31, 2011	Hurricane Irene
EM-3354 DR-4086	October 26 – November 8, 2012	October 28, 2012 October 30, 2012	Hurricane Sandy
DR-4231	June 23, 2015	July 22, 2015	Severe Storm
DR-4574	August 4, 2020	December 11, 2020	Tropical Storm Isaias

Source: FEMA 2020

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2015 and 2020, Camden County has been included in the following USDA disaster declaration in relation to severe summer storms as indicated in Table 4.3.11-5.

Table 4.3.11-5. Severe Summer Storm-Related USDA Disaster Declarations, 2015 to 2020

Declaration	Event Date	Declaration Date	Event Description
S3931	May 28 – July 15, 2015	November 4, 2015	Excessive rain, flash flooding, high winds, and lightning

Source: USDA 2020

Severe summer weather events that have impacted Camden County between 2015 and 2020 are identified in Table 4.3.11-6. With severe weather documentation for New Jersey and Camden County being so extensive, not all sources have been identified or researched. Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality, when available.

Table 4.3.11-6. Severe Summer Weather Events in Camden County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Camden County Designated?	Location	Description
July 23, 2016	Hail	N/A	N/A	Delair, Pennsauken Township	Hail with thunderstorms was measured at 0.75 to 1.0 inches in diameter.
June 29, 2019	Hail	N/A	N/A	Sicklerville	Damaging Winds as well as hail reaching 1.0 inches in diameter.
August 19, 2019	Hail	N/A	N/A	Cherry Hill Township	Severe Storms produced damaging winds and 1.5 inch hail.
July 22, 2020	Lightning	N/A	N/A	Pine Hill, Winslow Township	Lightning struck a house on Breckenridge Dr in the Sicklerville section of Winslow Twp. This resulted in a fire which left the home uninhabitable due to smoke and water damage. No injuries were reported.

Source: FEMA 2020; NCDC 2020; NWS 2020; SPC 2020; NJ HMP 2019; USGS 2011; NHC 2020; NOAA 2020
 DR Disaster Declaration (FEMA) FEMA Federal Emergency Management Agency
 N/A Not Applicable

4.3.11.4 Future Occurrences

Camden County is expected to continue experiencing direct and indirect impacts of severe weather annually. These storms may induce secondary hazards such as flooding and utility failure. In Section 4.4, the identified hazards of concern for Camden County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for severe storms in the County is considered 'occasional'.

The table below shows these statistics, as well as the annual average number of events and the percent chance of these individual flood hazards occurring in Camden County in future years based on the historic record (NOAA NCEI 2020).

Table 4.3.11-7. Probability of Future Occurrence of Severe Summer Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Percent (%) chance of occurrence in any given year
Hail	53	0.76	1.34	74.6%
Lightning	15	0.21	4.74	21.1%
Total	68	0.97	1.04	96.2%

Source: NOAA-NCDC 2020

Note: Probability was calculated using the available data provided in the NOAA-NCEI storm events database. Due to limitations in data, not all severe weather events occurring between 1950 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated. A 100 percent chance of occurring means that at least one severe weather event is likely to occur annually.

4.3.11.5 Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State’s average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70 percent of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation.

As temperatures increase, Earth’s atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9-percent increase. By 2050, annual precipitation in New Jersey could increase by 4-percent to 11-percent (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011). New Jersey could also experience an increase in the number of flood events (Broccoli et al. 2020).

A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor’easters, snowstorms, spring and summer thunderstorms, tropical storms, and 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 New Jersey, storms that resulted in extreme rain increased by 71-percent (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017).

4.3.11.6 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable. For the summer weather hazard, the entire County is exposed. The following section discusses Camden County's vulnerability, in a qualitative nature, to the summer weather hazard.

Impact on Life, Health and Safety

The entire population of Camden County is exposed to summer weather events (population of 506,738 people, according to the 2015-2019 American Community Survey population estimates). Hail and lightning events could cause potential health impacts including injury and death. According to the New Jersey State 2019 Hazard Mitigation Plan, there are a few incidents of minor hail events that occur each year, but the State has no reported deaths caused by hailstorms (NJ OEM 2019). Overall, this suggests that hailstorms have minimal health impacts on the County's population. However, the community's safety is still at risk during hail events that cause damage to property.

Lightning may cause greater health issues for people with preexisting medical conditions, such as cardiovascular disease, or for people with substance abuse issues (CDC 2014). The Department of Health and Human Services indicates that persons over the age of 65 are more likely to have cardiovascular disease or other heart conditions (USDHHS 2018). Although anyone can be at risk to impacts from being struck by lightning, persons over the age of 65 are likely to be the most vulnerable to impacts from lightning caused by severe summer weather. In Camden County, 15.4-percent of the population is over the age of 65 (77,791 persons).

Impact on General Building Stock

All buildings are exposed to summer weather hazards such as hailstorms and lightning strikes. Refer to Section 3 (County Profile), which summarizes the building inventory in Camden County. While hailstorms are not frequently known to cause major injuries or damage in New Jersey, an extreme event can carry hail stones traveling at speeds greater than 100 miles per hour (NOAA 2021). 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).

Impact on Critical Facilities and Lifelines

All critical facilities and lifelines in the County are exposed to the summer weather hazards. Impacts to critical facilities that are buildings are the same as described for the general building stock. It is essential that critical facilities remain operational during natural hazard events. Fires caused by lightning and structural damages caused by extreme hail events would need to be mitigated to prevent any residual impacts from occurring, such as loss of power to essential utilities (e.g., HVAC, water).

Impact on the Economy

Extreme summer weather events also have impacts on the economy, including loss of business function and damage to and loss of inventory. Business-owners can be faced with increased financial burdens due to unexpected repairs caused to the building (e.g., structural damages or fires) or business interruption due to power failure (i.e., loss of electricity, telecommunications). Disruptions in public transportation service will also impact the economy for both commuters and customers alike.

Impact on the Environment

Extreme summer weather events can also impact the environment. The EPA found that lightning generates nitrogen oxides, which could have an impact on ground-level ozone (EPA 2018). Hailstorms can also be detrimental to the environment depending on the size and velocity of these stones and the location of their impact. Large hail stones could cause damage to plants and could be deadly to animals.

Future Changes that May Impact Vulnerability

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

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

Projected Development

The ability of new development to withstand extreme summer weather hazard impacts lies in sound land use practices, building design considerations (e.g., Leadership in Energy and Environmental Design [LEED]), and consistent enforcement of codes and regulations for new construction. New development will change the landscape where buildings, roads, and other infrastructure potentially replace open land and vegetation. Surfaces that were once permeable and moist are now impermeable and dry, potentially making them more susceptible to fires caused by lightning.

The Pinelands Commission has identified Pinelands Management Area Boundaries, including regional growth areas and rural development areas that may also provide insight to where development and growth may occur in the County. In addition, each community was requested to provide recent and anticipated new development and infrastructure projects; summarized in Section 9 (Jurisdictional Annexes). According to the data provided by the communities, there are approximately 89 recent and anticipated new development projects for Camden County. While this number of new development projects could be underestimated, this best available data provides insight about future risk of impacts from summer weather events for the County.

Specific areas of recent and new development are indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 (Jurisdictional Annexes) of this plan.

Projected Changes in Population

Camden County has experienced population decline since 2010. According to the U.S. Census Bureau, the County's population has decreased 1.3-percent between 2010 and 2019 (U.S. Census Bureau 2020). Even though the population has decreased, any changes in the density of population can impact the number of persons exposed to the summer weather hazard.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures. As the climate warms, the intensity of summer weather may change, with the potential to create more frequent events with lightning and/or hail.

4.3.11.7 Change of Vulnerability Since the 2017 HMP

Overall, the entire County remains vulnerable to summer weather events.

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