8. EXTREME TEMPERATURES

8.1 HAZARD PROFILE

8.1.1 Hazard Description

Extreme temperature includes both heat and cold events, which can have a significant impact on human health, commercial/agricultural businesses, and primary and secondary effects on infrastructure (such as burst pipes and power failure). What constitutes extreme cold or extreme heat can vary across different areas of the country, based on temperatures that are typical for the area.

Extreme Cold

Extreme cold events occur when temperatures drop well below what is normal for an area. For example, near-freezing temperatures are considered “extreme cold” in regions relatively unaccustomed to winter weather. In regions that are subjected to temperatures below freezing on a regular basis, “extreme cold” might be used to describe temperatures below 0 °F. For the purposes of this HMP, extreme cold is defined as when the ambient air temperature drops to 0 ºF or below (NWS n.d.). It also considers wind chill, which is how wind and cold feel on exposed skin. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature.

Extreme Heat

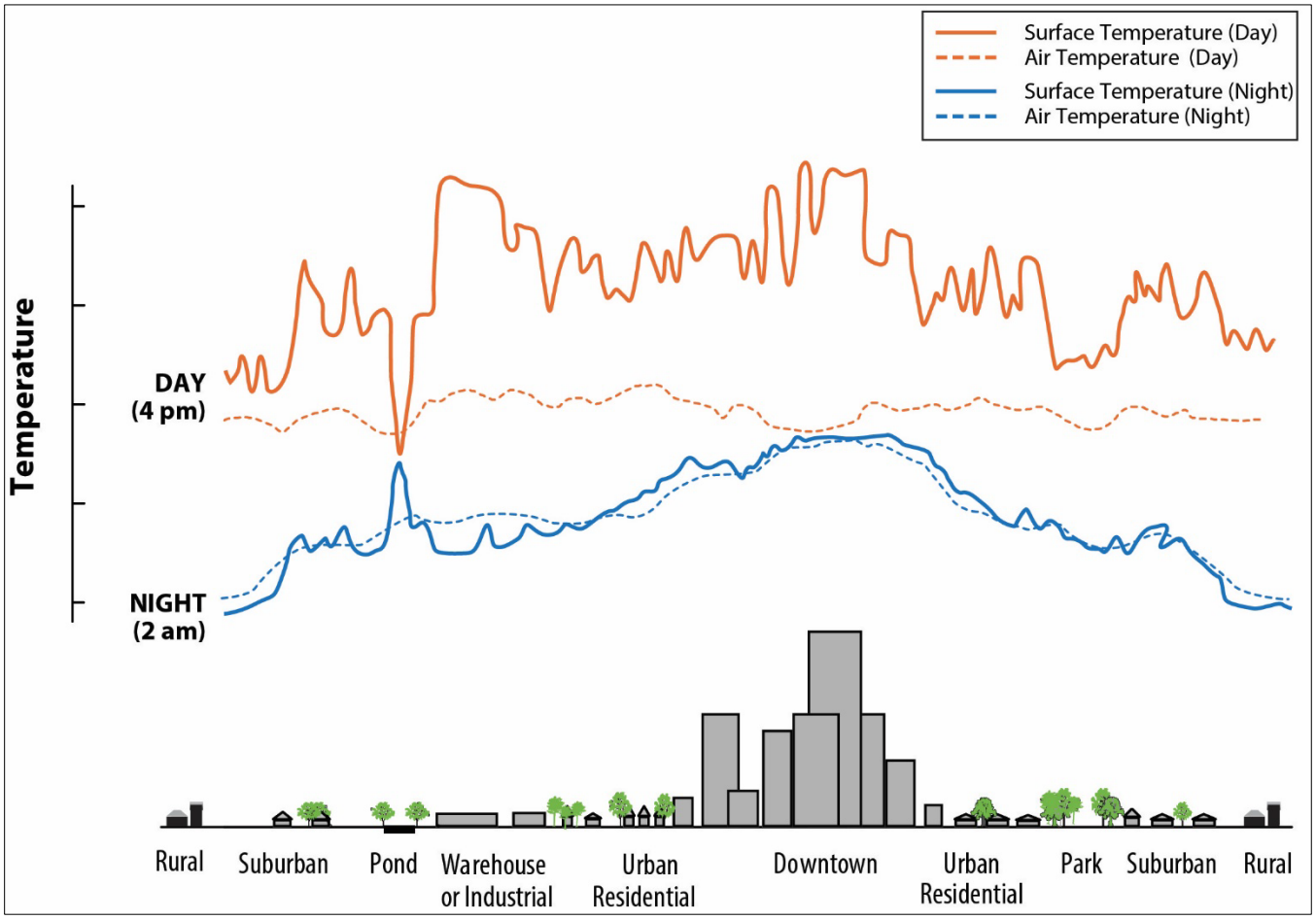
Extreme heat is defined as temperatures that hover 10 °F or more above the average high temperature for a region (CDC 2024). A heat wave is a period of abnormally and uncomfortably hot and unusually humid weather. Humid or muggy conditions occur when a dome of high atmospheric pressure traps hazy, damp air near the ground. A heat wave will typically last two or more days (NOAA n.d.).

Urbanization exacerbates risk during an extreme heat event. As urban areas develop, buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist become impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas, forming an “island” of higher temperatures. A “heat island” is a built up area that is hotter than nearby rural areas. The annual mean air temperature of a city with more than 1 million people can be 2 ºF to 5 ºF warmer than its surroundings. In the evening, the difference in air temperatures can be as high as 22 ºF.

As shown in Figure 8-1, surface temperatures vary more than atmospheric air temperatures during the day, but they are generally similar at night. On a hot, sunny day, the sun can heat dry, exposed urban surfaces to temperatures 50 ºF to 90 ºF hotter than the air. The dips and spikes in surface temperatures over the pond area show how water maintains a nearly constant temperature day and night because it does not absorb the sun’s energy the same way as buildings and paved surfaces. Parks, open land, and bodies of water can create cooler areas within a city. Temperatures are typically lower at suburban-rural borders than in downtown areas.

Heat islands can affect communities by increasing peak energy demand during the summer, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and death, and water quality degradation (EPA 2024).

Figure 8-1. Urban Heat Island Effect Diagram



Source: US EPA 2023

8.1.2 Location

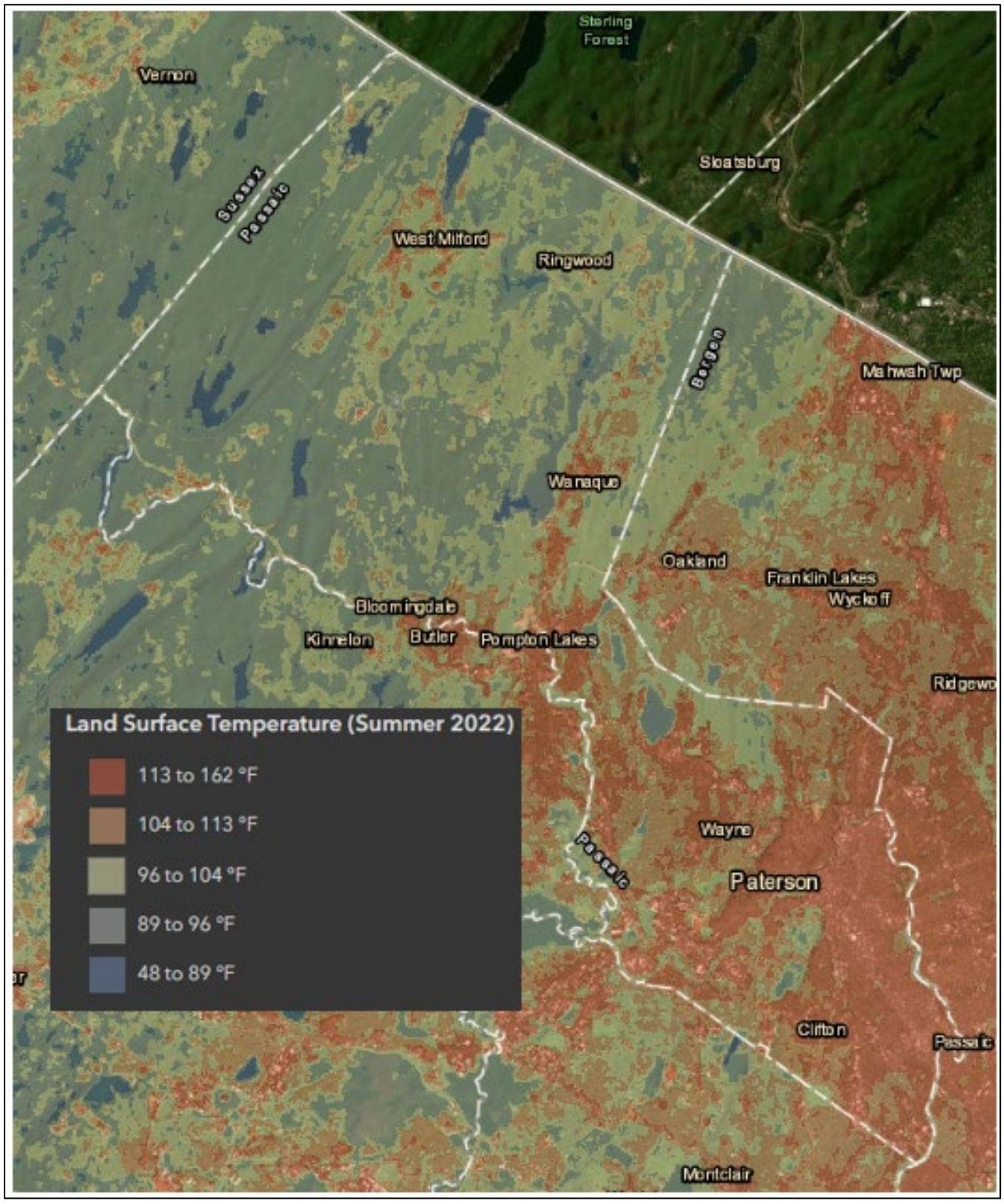
NJDEP used satellite imagery in the summer of 2022 to map land surface temperatures across the state. The highest land surface temperatures (113°F to 162°F) were concentrated in Bergen, Essex, Hudson, Middlesex, and Union counties as well as eastern Passaic County and central Somerset County (NJOEM 2024). Figure 8-2 shows the land surface temperature for Passaic County from the NJDEP study.

8.1.3 Extent

Extreme Cold

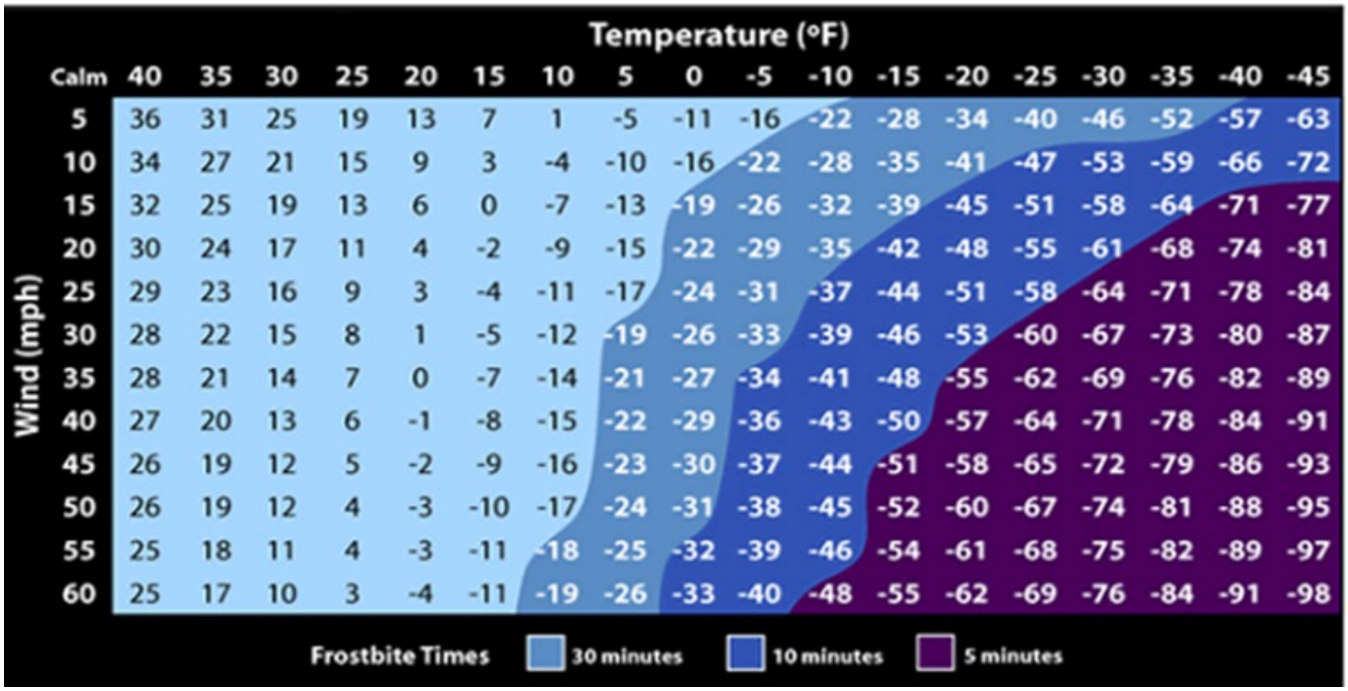
The extent (severity or magnitude) of extreme cold temperatures is generally measured through the wind chill index (see Figure 8-3). Wind chill represents what the air temperature feels like to the human skin due to the combination of cold temperatures and winds blowing on exposed skin. The colder the air temperature and the higher the wind speeds, the colder it will feel on skin (NOAA n.d.). The wind chill index is only applicable when temperatures are at or below 50°F and wind speeds are above 3 mph.

Figure 8-2. UHI Effect and Land Surface Temperature in Passaic County



Source: (NJDEP 2023)

Figure 8-3. Wind Chill Index



Source: NWS 2021

As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature. Wind amplifies the cooling effect by blowing away the thin layer of warm air near a person's skin, making it feel colder than the actual air temperature. The following health hazards are related to extreme cold temperatures (NWS 2022):

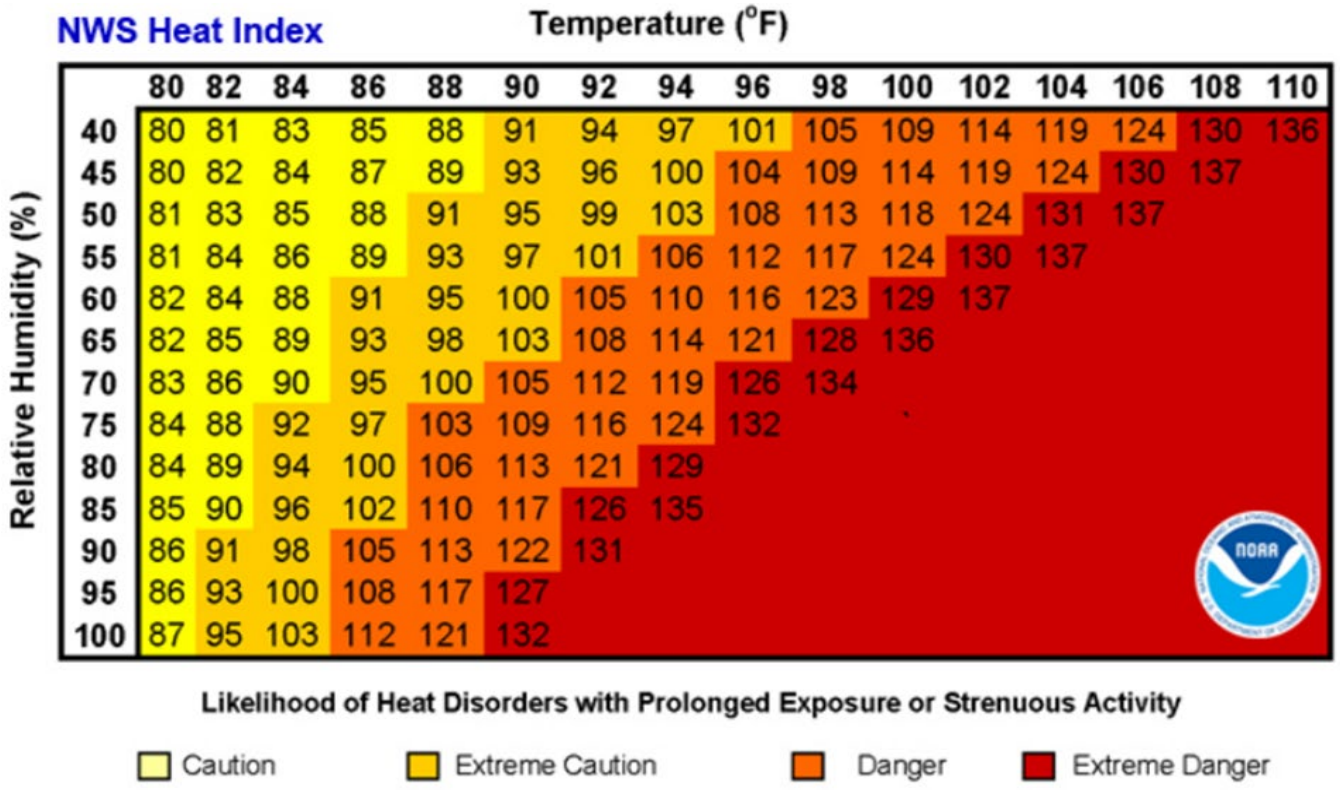
- Frostbite is damage to body tissue caused by extreme cold. A wind chill of -20 °F will cause frostbite in just 30 minutes. Frostbite can cause a loss of feeling and a white or pale appearance in extremities.
- Hypothermia is a condition brought on when the body temperature drops to less than 95 °F, and it can be deadly. Warning signs of hypothermia include uncontrollable shivering, memory loss, disorientation, incoherence, slurred speech, drowsiness, and apparent exhaustion.

Extreme Heat

The extent of extreme heat temperatures is generally measured through the heat index, identified in Figure 8-4. The heat index measures apparent temperature of the air as it increases with the relative humidity. The values are determined for shady, light wind conditions. Exposure to full sun can increase the index by up to 15 °F (NYS DHSES 2023). Table 8-1 outlines the effects of prolonged exposure to heat on the human body during extreme heat.

The NWS issues excessive heat outlooks when the potential exists for an excessive heat event in the next three to seven days. Watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. Excessive heat warning/advisories are issued when an excessive heat event is expected in the next 36 hours (NWS 2021).

Figure 8-4. NWS Heat Index Chart – Shaded Areas



Source: NWS 2021

Table 8-1. Adverse Effects of Prolonged Exposure to Heat

Category	Heat Index	Effects on the Body
Caution	80°F - 90°F	Fatigue is possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion is possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion is likely, and heat stroke is possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke is highly likely

Source: NWS n.d.

The following health hazards are related to extreme high temperatures (CDC 2024):

- Heat exhaustion is the body's response to an excessive loss of water and salt, usually through excessive sweating. Symptoms can include headache, cramping, dizziness, and weakness.
- Heat stroke occurs when the body can no longer control its temperature: the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. When heat stroke occurs, the body temperature can rise to 106°F or higher within 10 to 15 minutes. Heat stroke can cause permanent disability or death if the person does not receive emergency treatment.

8.1.4 Previous Occurrences

FEMA Major Disaster and Emergency Declarations

Passaic County has not been included in any major disaster (DR) or emergency (EM) declarations for extreme-temperature-related events (FEMA 2023).

USDA Declarations

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans from the U.S. Department of Agriculture (USDA) to producers suffering losses in those counties and in contiguous counties. Between 2017 and 2023, Passaic County was included in four USDA extreme temperature-related agricultural disaster declarations, as listed in Table 8-2.

Table 8-2. USDA Declarations for Extreme Temperatures Events in Passaic County (2017 to 2023)

Event Date	USDA Declaration Number	Description
April 6, 2020 to May 15, 2020	S4748	Freeze and frost
August 9, 2022	S5306	Drought; Persistent Dry/Hot Conditions
July 1, 2022 to August 19, 2022	S5345	Drought and Excessive Heat
May 17 – 18, 2023	S5644	Freeze and Frost

Source: USDA 2024

Previous Events

Known hazard events that impacted Passaic County between August 2019 and December 2023 are listed in Table 8-3. For events prior to 2019, refer to the 2020 Passaic County HMP.

Table 8-3. Extreme Temperature Events in Passaic County (2019 to 2023)

Event Date	FEMA Declaration Number	Passaic County Included in Declaration?	Location Impacted	Description
April 6 – May 15, 2020	N/A	N/A	Countywide	Freeze and frost, USDA declaration S4748
August 9, 2022	N/A	N/A	Countywide	Drought; Persistent Dry/Hot Conditions, USDA declaration S5306
July 1 – August 19, 2022	N/A	N/A	Countywide	Drought and Excessive Heat, USDA declaration S5345
May 17 – 18, 2023	N/A	N/A	Countywide	Freeze and Frost, USDA declaration S5644

Source: NOAA NCEI 2024; USDA 2024

8.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

Information on previous extreme temperature occurrences in the County was used to calculate the probability of future occurrence of such events, as summarized in Table 8-4. Based on historical records and input from the Steering Committee, the probability of occurrence for extreme temperature in the County is considered “frequent.”

Table 8-4. Probability of Future Extreme Temperature Events in Passaic County

Hazard Type	Number of Occurrences Between 1996 and 2023	Percent Chance of Occurring in Any Given Year
Extreme Cold/Wind Chill	8	28%
Cold/Wind Chill	2	7%
Excessive Heat	6	21%
Heat	10	36%
Total	**26**	**93%**

Source: FEMA 2023; NOAA NCEI 2024; USDA 2024
Note: Due to limitations in data, not all extreme temperature events occurring are accounted for in the tally of occurrences.

Effect of Climate Change on Future Probability

Climate change includes major changes in temperature over several decades or longer. Since the end of the 1890s, New Jersey has experienced a 3.5° F increase in average temperature, which is greater than the increase in the rest of the northeastern United States(2° F) and the world (1.5° F) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in the State of New Jersey are expected to increase by 4.1 to 5.7 °F. Future temperatures could be as much as 10° F warmer than historical averages.

The state 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. The increase in temperatures is expected to be felt more during the winter (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation (NJDEP 2020).

8.1.6 Cascading Impacts on Other Hazards

Extreme temperature events can exacerbate the drought hazard, increase the potential risk of wildfires, and escalate severe weather and severe winter weather events for the County. For example, extreme heat events may accelerate evaporation rates, which may dry out the air and soils, making some terrestrial plants and soil more susceptible to catching fire. Extreme variation in temperatures could also create ideal atmospheric conditions for severe storms or worsen the outcome of severe winter weather during freezing and thawing periods. Extreme cold may result in an increase in flooding as a result of ice jams altering the flow and release of water.

8.2 VULNERABILITY AND IMPACT ASSESSMENT

All of Passaic County has been identified as the hazard area for extreme temperatures. Therefore, all assets in the County (population, structures, critical facilities, and lifelines) are vulnerable to this hazard.

8.2.1 Life, Health, and Safety

Overall Population

The entire population of Passaic County (519,986) is exposed to extreme temperature events. Potential health impacts include injury and death. Health hazards related to extreme cold temperatures include wind chill, frostbite, and hypothermia. Health hazards related to extreme high temperatures include heat exhaustion and heat stroke. Adhering to extreme temperature warnings and conducting appropriate mitigation and preparation measures can significantly reduce the risk of temperature-related deaths.

Workers who are exposed to extreme heat may be at risk of heat stroke, heat exhaustion, heat cramps, or heat rashes. Heat can also increase the risk of injuries in workers as it may result in sweaty palms, fogged-up safety glasses, and dizziness. Burns may occur as a result of accidental contact with hot surfaces. Working outdoors increases the chances of getting sunburned (Centers for Disease Control and Prevention 2020, Centers for Disease Control and Prevention 2018). Workers exposed to extreme cold temperatures may experience cold stress, leading to cold-related illnesses such as hypothermia, frostbite, trench foot, and chilblains (CDC 2024).

Socially Vulnerable Population

Socially vulnerable populations most at risk to extreme cold and heat events include the elderly, who are less able to withstand temperatures extremes due to their age, health conditions, and limited mobility to access shelters; infants and children up to four years of age; individuals with chronic medical conditions (e.g., heart disease, high blood pressure), and low-income persons that cannot afford proper heating and cooling (CDC 2022, CDC 2005).

Extreme heat can lead to heat-related illnesses such as heatstroke and dehydration, with vulnerable groups often having limited access to air conditioning and cooling centers, increasing their risk (NIHHIS n.d.). Many socially vulnerable individuals work in outdoor or non-climate-controlled environments, such as construction and agriculture, making them more susceptible to heat-related health issues and reduced productivity.

Extreme cold can exacerbate chronic conditions, like cardiovascular and respiratory diseases, with vulnerable populations struggling to afford adequate heating, increasing their risk of hypothermia and frostbite (NIEHS 2022). Poorly insulated housing and homelessness significantly heighten the risks associated with extreme cold, as these groups often lack the resources to improve their living conditions. Additionally, extreme cold can disrupt transportation and access to essential services, such as healthcare and food supplies, disproportionately affecting those with limited mobility or financial resources (EPA 2024).

Without a quantitative assessment of potential impacts of extreme temperatures on socially vulnerable populations, the Planning Partners can best assess mitigation options through an understanding of the general numbers and locations of such populations across Passaic County. Section 3.6.3 provides detailed data on socially vulnerable populations within the planning area. Table 8-5 summarizes highlights of this information. For planning purposes, it is reasonable to assume that percentages and distribution of socially vulnerable populations affected by extreme temperatures will be similar to the countywide numbers.

Meteorologists can accurately forecast extreme heat and cold events and the severity of the associated conditions with several days of lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations, implement short-term emergency response actions, and focus on surveillance and relief efforts on those at greatest risk.

Table 8-5. Distribution of Socially Vulnerable Populations by Municipality

Category	Sussex County Total		Municipality Highest in Category		Municipality Lowest in Category	
	Number	Percent	Number	Percent	Number	Percent
			Paterson	North Haledon	Prospect Park	Passaic
Population Over 65	**78,440**	**15.10%**	**18,141**	**24.6%**	**625**	**9.0%**
			Paterson	Passaic, Prospect Park	Bloomingdale	Bloomingdale
Population Under 5	**33,502**	**6.40%**	**12,442**	**8.3%**	**247**	**3.2%**
Non-English-Speaking Population	**68,953**	**13.30%**	Paterson **34,885**	Passaic **22.4%**	Bloomingdale, Ringwood **104**	Ringwood **0.9%**
Population With Disability	**46,707**	**9.00%**	Paterson **12,756**	Prospect Park **14.3%**	Bloomingdale **588**	Pompton Lakes **7.2%**
Population Below Poverty Level	**68,995**	**13.30%**	Paterson **37,143**	Paterson **23.5%**	Ringwood **262**	Ringwood **2.2%**
Households Below ALICE Threshold	**62,752**	**35%**	Paterson **33,284**	Paterson **67%**	North Haledon **745**	Ringwood **22%**

8.2.2 General Building Stock

All the building stock in the County is exposed to the extreme temperature hazard. Extreme heat generally does not impact buildings; however, elevated summer temperatures increase the energy demand for cooling. Losses can be associated with the overheating of heating, ventilation, and air conditioning (HVAC) systems.

Extreme cold temperature events can damage buildings through freezing/bursting pipes and freeze/thaw cycles, as well as increasing vulnerability to home fires. Additionally, manufactured homes and older or poorly constructed buildings often lack adequate capabilities to withstand extreme temperatures. These deficiencies can include insufficient insulation and less efficient heating systems.

8.2.3 Community Lifelines and Other Critical Facilities

Direct impacts on structures are expected to be minimal. However, it is essential that critical facilities remain operational during natural hazard events. Extreme heat events can sometimes cause short periods of utility failures, commonly referred to as brownouts, created by increased usage from air conditioners, appliances, and similar equipment. Heavy snowfall and ice storms associated with extreme cold temperatures can interrupt power as well. Backup power is recommended for critical facilities and infrastructure. Additionally, designating and developing emergency cooling or heating facilities can enhance the resilience and safety of communities.

8.2.4 Economy

Extreme temperature can lead to loss of business function and damage inventory. Business owners may be faced with increased financial burdens due to unexpected repairs (e.g., pipes bursting), higher than normal utility bills, or business interruption caused by power failure (e.g., loss of electricity and telecommunications) (NJOEM 2024). The agricultural industry is most at risk in terms of economic impact and damage caused by extreme temperature. Extreme heat events can result in drought and directly affect livestock and crop production.

Based on the 2022 Census of Agriculture, 99 farms were present in Passaic County, encompassing 1,830 acres of farmland. The average farm size was 18 acres. Passaic County farms had a total market value of products sold of approximately $4.7 million for crops and approximately $275,000 for livestock (USDA 2024).

8.2.5 Natural, Historic and Cultural Resources

Natural

During periods of extreme heat, air quality in Passaic County deteriorates significantly. Additionally, the combination of high temperatures and little rainfall creates ideal conditions for wildfires, which further degrade air quality by producing smoke.

Water resources are also heavily impacted by extreme heat. Prolonged high temperatures lengthen the growing season, increasing the demand for irrigation and affecting groundwater volumes. Drought conditions, often associated with extreme heat, can strain both surface and groundwater supplies, especially in areas with limited reservoirs. Freshwater and coastal wetlands face challenges as well. Increased drought frequency and intensity reduce the availability of freshwater vernal pools, which are crucial habitats for many sensitive wildlife species. Rising temperatures also create favorable conditions for invasive species like the clinging jellyfish (NJDEP 2020). Moreover, runoff from hot surfaces elevates the temperature of waterways, further stressing aquatic ecosystems.

Forests and vegetated lands are at heightened risk during extreme heat events. Dry conditions and high temperatures increase the likelihood and duration of wildfires (NJDEP 2020). Additionally, the warmer climate accelerates the maturation of insect pests, allowing them to invade new vegetated areas that previously did not experience such pressures.

Prolonged cold spells can freeze wetland soils, reducing water seepage and causing snowmelt runoff to bypass wetlands (NJOEM 2024). This makes water unavailable during the crucial spring and summer months. Heavy snow and ice accumulation during extreme cold weather can damage trees and crops by breaking vegetation and tree limbs. Prolonged periods of extreme cold can also harm vegetation and crops, negatively impacting the agricultural industry in the region (NJOEM 2024).

Historic

Historic buildings may be susceptible to damage from extreme temperature conditions. Extreme heat can increase the risk of ignition of fires and their propagation. Fire may increase the probability of cracking or splitting in built structures. Long-term impacts include weakened stones and increased susceptibility to deterioration processes such as salt weathering and temperature cycling (Sesana, et al. 2021).

Proper strategies help safeguard buildings and their contents. Sudden and dramatic fluctuations in heating or cooling should be minimized. Slower heating and cooling give building materials and stored contents time to acclimate to new temperatures in the building and corresponding new humidity levels (CCAHA 2019).

Cultural

Historical buildings and homes, which house many cultural artifacts, may not be built to withstand extreme temperature fluctuations, making them more vulnerable to damage. Changes in temperature can affect the structure and composition of building materials, accelerating physical, chemical, and biological degradation processes (Sesana, et al. 2021). Extreme heat can increase the risk of ignition of fires and their propagation. Fire causes material loss and deformation of cultural heritage assets.

8.3 FUTURE CHANGES THAT MAY AFFECT RISK

8.3.1 Potential or Planned Development

New development will change the landscape where buildings, roads, and other infrastructure replace open land and vegetation. Transformation of pervious surfaces (including vegetation) to impervious surfaces causes an island of higher temperatures. Green space preservation will need to continue to be a priority to mitigate increased heat islands. Specific areas of recent and new development are indicated in the jurisdictional annexes in Volume II of this plan. The ability of new development to withstand extreme temperature impacts can be enhanced through land use practices and consistent enforcement of codes and regulations for new construction.

8.3.2 Projected Changes in Population

Population change is not expected to have a measurable effect on the overall vulnerability of the County's population over time. However, drastic increases in less densely populated areas of the County may require utility system upgrades to keep up with demands (e.g., water, electric) during extreme temperature events to prevent increased stresses on these systems.

Furthermore, an increase in the socially vulnerable population, including low-income households, elderly residents, and individuals with pre-existing health conditions, can exacerbate the impacts of extreme heat and cold events (EPA 2025).

The New Jersey Department of Labor and Workforce Development produced population projections by County for 2029 and 2034. According to these projections, Passaic County is projected to have an increase in population in the upcoming years. These projections include a population of 536,100 by 2029 and 542,500 by 2034 (State of New Jersey 2017).

8.3.3 Climate Change

Projections indicate that New Jersey will continue to warm, with annual temperatures expected to be as warm as the warmest years in the historical record by 2050. This increase in average annual temperatures will lead to more intense heat waves and fewer cold waves, extending the growing season and decreasing the number of sub-freezing days and snow accumulation. As the climate warms, extreme cold events might decrease in frequency, while extreme heat events might increase in frequency and intensity.

Vulnerable populations could face increased risks of heat-related illnesses, and more buildings, facilities, and infrastructure systems may exceed their ability to cope with the heat. Thus, improving building efficiency and upgrading heating and cooling technology will become increasingly important for businesses and homeowners.

8.3.4 Other Identified Conditions

Extreme temperatures can place significant stress on infrastructure, including roads, bridges, and buildings. High temperatures cause materials to expand and contract, leading to cracks and other forms of damage. Additionally, there is often an increased demand for energy during extreme temperatures, particularly for heating and cooling. This surge in energy use can lead to power outages and increased stress on energy grids. Transportation systems are also affected by extreme heat, with rail tracks potentially buckling and asphalt softening.