7. DROUGHT

7.1 Hazard Profile

7.1.1 Hazard Description

As defined by the National Weather Service (NWS), drought is a deficiency in precipitation over an extended period resulting in a water shortage causing adverse impacts on vegetation, animals, and/or people (NOAA 2018). It is a normal, recurrent feature of climate that occurs in virtually all climate zones, from very wet to very dry. Drought is a temporary aberration from normal climatic conditions and can vary significantly from one region to another. Human factors, such as water demand and water management, can exacerbate the impact that a drought has on a region. There are five different ways that drought can be defined or grouped (NDMC n.d.):

- *Meteorological drought* is a measure of departure of precipitation from normal. It is defined solely on the relative degree of dryness. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.
- *Agricultural drought* links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced ground water or reservoir levels, and other parameters. It occurs when there is not enough water available for a particular crop to grow at a particular time. Agricultural drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- *Hydrological drought* is associated with the effects of periods of precipitation shortfalls (including snowfall) on surface or subsurface water supply. It occurs when these water supplies are below normal. It is related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
- *Socioeconomic drought* is associated with the supply and demand of an economic good with elements of meteorological, hydrological, and agricultural drought. This differs from the types of droughts because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods depends on the weather (for example water, forage, food grains, fish, and hydroelectric power). Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply.
- *Ecological drought* is a prolonged and widespread deficit in naturally available water supplies — including changes in natural and managed hydrology — that create multiple stresses across ecosystems.

Water in hydrologic storage systems (e.g., reservoirs, rivers) is often used for multiple and competing purposes (e.g., flood control, irrigation, recreation, navigation, hydropower, or wildlife habitat), further complicating the sequence and quantification of impacts. Competition for water in these storage systems escalates during drought and conflicts between water users increase significantly (NDMC n.d.).

7.1.2 Location

Climate divisions are regions within a state that are climatically homogenous. The National Oceanic and Atmospheric Administration (NOAA) has divided the U.S. into 359 climate divisions. The boundaries of these divisions typically coincide with the county boundaries, except in the western U.S., where they are based largely on drainage basins (NCEI 2023). According to NOAA, New Jersey is made up of three climate divisions: Northern, Southern, and Coastal (NCEI 2023). Hudson County is in the Northern Climate Division.

Drought regions allow the State of New Jersey to respond to changing conditions without imposing restrictions on areas not experiencing water supply shortages. These regions were developed based upon hydrogeologic conditions, watershed boundaries, municipal boundaries, and water supply characteristics. The drought regions align with municipal borders because the primary enforcement mechanism for water restrictions during a drought emergency is the local police department (NJDEP 2022). The State of New Jersey is divided into six drought regions that are based on regional similarities in water supply sources and rainfall patterns. Hudson County is in the Northeast Drought Region. According to the New Jersey Department of Environmental Protection (NJDEP), water supply sources available to this region include rivers and New Jersey reservoirs, both major supply sources, and unconfined groundwater (minor supply source) (NJDEP 2023). Figure 7-1 shows the drought regions of the State with Hudson County circled in red.

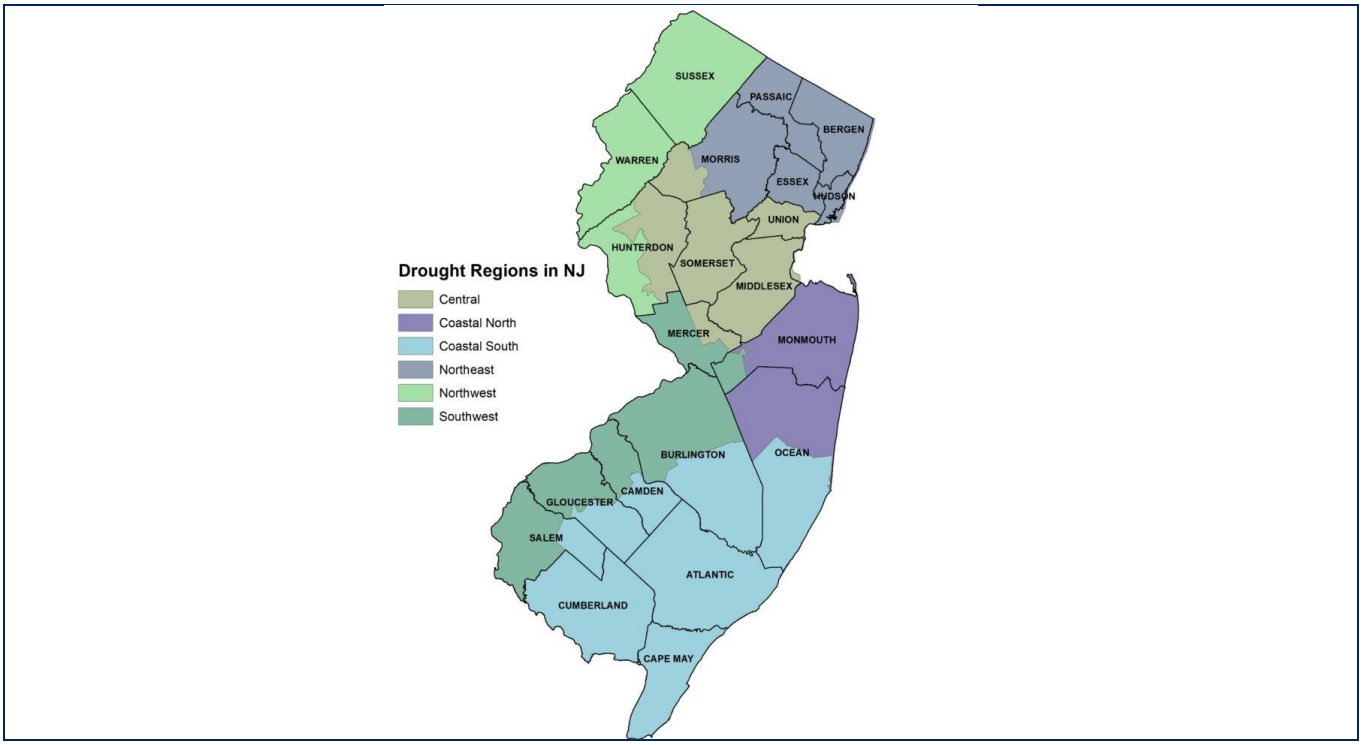
Surface waters in New Jersey provide much of the water used for drinking supplies, as well as for recreation, fishing, tourism, and commercial uses (NJDEP 2023). The State is divided into five water regions based upon watershed management area and hydrologic unit codes (HUC). Hudson County is located within the Passaic water region, with a small portion of the County falling within the Raritan region; refer to Figure 7-2. In terms of annual water withdrawal by sector in the Passaic water region, the majority is for potable water supply and power generation, with a small percent of surface water used for commercial, industrial or mining purposes. By comparison, in the Raritan region, nearly all withdrawals are for potable supplies. Water use trends, like withdrawal trends, vary from month to month with water use typically peaking during summer months when outdoor and irrigation demands are high (NJDEP 2024).

Over 1.2 billion gallons of potable water are used in New Jersey each day, with 88 percent of the State's population receiving its drinking water from public community water systems. A public water system is defined as a water system that pipes water for human consumption that has at least 15 service connections or regularly serves at least 25 individuals 60 days or more a year. About half the State's population receives its drinking water from surface water, the rest from ground water (NJDEP 2024)

7.1.3 Extent

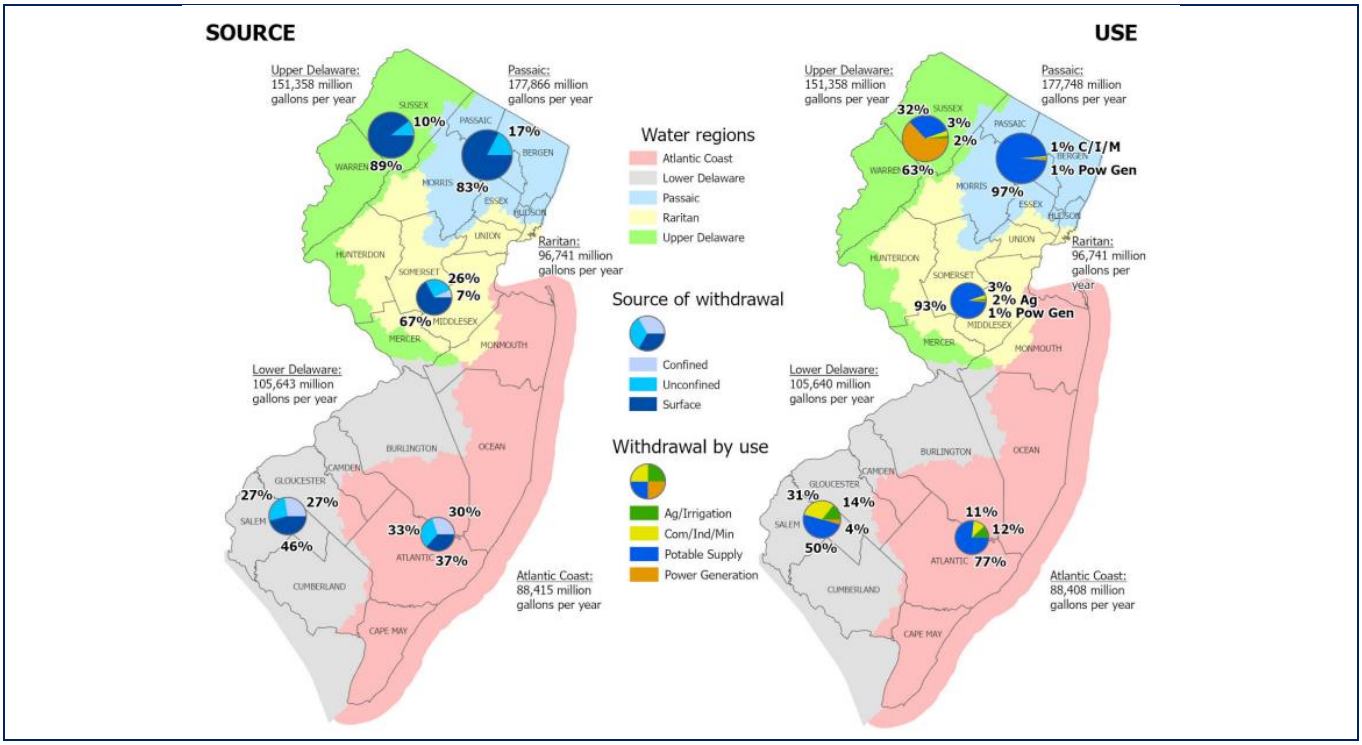
The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts (NIDIS 2023). The State of New Jersey uses a multi-index system that takes advantage of multiple indices to determine the severity of a drought or extended period of dry conditions (NJDEP 2024).

Figure 7-1. New Jersey Drought Regions



Source: NJDEP

Figure 7-2. New Jersey Water Regions, Sources, and Withdrawals by Sector



Source: (NJDEP 2024)

Palmer Drought Severity Index

The Palmer Drought Severity Index (PDSI) is commonly used by drought monitoring agencies for drought reporting. The PDSI is primarily based on soil conditions. Soil with decreased moisture content is the first indicator of an overall moisture deficit. Table 7-1 lists the PDSI classifications. At the one end of the spectrum, zero is used as normal and drought is indicated by negative numbers. For example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The PDSI also reflects excess precipitation using positive numbers; however, this information is not included in Table 7-1 (NCAR 2023).

Table 7-1. Palmer Drought Category Descriptions

Category	Description	Possible Impacts	Palmer Drought Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting and growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.99
D1	Moderate drought	Some damage to crops and pastures; fire risk high; streams, reservoirs, or wells low; some water shortages developing or imminent; voluntary water-use restrictions requested.	-2.0 to -2.99
D2	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-3.0 to -3.99
D3	Extreme drought	Major crop or pasture losses; extreme fire danger; widespread water shortages or restrictions.	-4.0 to -4.99
D4	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.	-5.0 or less

Source: NCAR 2023

Watches, Warnings, and Emergencies

The Division of Water Supply and Geoscience within the NJDEP regularly monitors various water supply conditions within the State based on the five different Water Supply Regions. The water supply conditions aid NJDEP in declaring the regions as being within one of the four stages of water supply drought, Normal, Drought Watch, Drought Warning, and Drought Emergency (NJDEP 2024):

- ***Normal Conditions*** indicate no drought conditions are present. There is routine monitoring of water supply and meteorological indicators.
- A ***Drought Watch*** is an administrative designation made by NJDEP when drought or other factors begin to adversely affect water supply conditions. A Drought Watch indicates that conditions are dry but not yet significantly so. During a Drought Watch, NJDEP closely monitors drought indicators (including precipitation, stream flows and reservoir and ground water levels, and water demands) and consults with affected water suppliers. The aim of a Drought Watch is to avert a more serious water shortage that would necessitate declaration of a water emergency and the imposition of mandatory water use restrictions, bans on water use, or other potentially drastic measures.

- A ***Drought Warning*** represents a non-emergency phase of managing available water supplies during the developing stages of drought and falls between the Drought Watch and Drought Emergency levels of drought response. Under a Drought Warning, the commissioner of the DEP may order water purveyors to develop alternative sources of water or transfer water between areas of the State with relatively more water to those with less. While mandatory water use restrictions are not imposed under a Drought Warning, the general public is strongly urged to use water sparingly in affected areas.
- A ***Drought Emergency*** can only be declared by the governor. While drought warning actions focus on increasing or shifting the supply of water, efforts initiated under a water emergency focus on reducing water demands. During a water emergency, a phased approach to restricting water consumption is typically initiated. Phase I water use restrictions typically target non-essential, outdoor water use.

The National Weather Service Climate Prediction Center provides seasonal outlooks for droughts that last for three-month increments (NIDIS n.d.). Predicting the extent or severity of drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last will depend on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale (NIDIS n.d.).

7.1.4 Previous Occurrences

FEMA Major Disaster and Emergency Declarations

Between 1954 and 2023, Hudson County was included in two major disaster (DR) or emergency (EM) declarations for drought-related events (FEMA 2024). Table 7-2lists these declarations.

Table 7-2. FEMA Declarations for Drought Events in Hudson County (1954 to 2023)

Event Date	Declaration Date	Declaration Number	Description
August 18, 1965	August 18, 1965	DR-205-NJ	New Jersey Water Shortage
October 19, 1980	October 19, 1980	EM-3083-NJ	New Jersey Water Shortage

Sources: FEMA 2023

USDA Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in contiguous counties. Between 2017 and 2023, Hudson County was included in one USDA drought-related agricultural disaster declarations. For declarations that occurred between 2017 and 2023, refer to Table 7-3.

Table 7-3. USDA Declarations for Drought Events in Hudson County (2019 to 2023)

Event Date	USDA Declaration Number	Description
August 9, 2022	S5305	Drought

Sources: USDA 2024

Previous Events

Known hazard events that impacted Hudson County between August 2019 and December 2023 are discussed in Table 7-1. For events prior to 2019, refer to the 2019 Hudson County HMP.

Table 7-4. Drought Events in Hudson County (2019 to 2023)

Event Date	FEMA Declaration or State Proclamation Number	Hudson County included in declaration?	Location Impacted	Description
July 26 – August 25, 2022	N/A	N/A	Statewide	Water conservation urged in New Jersey as some reservoirs drop rapidly.
August 9 – November 11, 2022	USDA S5305	N/A	Statewide	New Jersey was under a statewide drought watch as drought and heat strain water supplies. USDA declaration issued for Hudson County, S5305.
June 20 – July 20, 2023	N/A	N/A	Statewide	Gov. Phil Murphy's administration urged residents and businesses to use water wisely due to the state's dry conditions.

Sources: USDA 2024, NOAA NCEI 2024. FEMA 2023

7.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

Table 7-5 provides calculated probability of future drought events in Hudson County. It is expected that Hudson County will continue to experience direct and indirect impacts of drought on occasion, with the secondary effects causing potential disruption or damage to agricultural activities and creating shortages in water supply within communities. Based on historical records and input from the Steering Committee, the probability of occurrence for drought in the County is considered "occasional."

Table 7-5. Future Occurrence of Drought Events in Hudson County

Hazard Type	Number of Occurrences Between 1950 and 2023	% Chance of Occurrence in Any Given Year
Drought	14	19%

Source: FEMA 2024; NJOEM 2024; NOAA NCEI 2024

Notes: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected drought events since 1968. Due to limitations in data, not all drought events occurring between 1950 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

Effect of Climate Change on Future Probability

The pressure on water resources due to diverse water demands are likely to be worsened by future climate change. Warming is projected by the end of the 21st century. Increases in the number of extremely hot days and decreases in the number of extremely cold days are projected to accompany the overall warming. According to state-level analysis,

by the middle of the 21st century an estimated 70 percent of summers in the northeast region are anticipated to be hotter than what the current warmest summers on record (National Centers for Environmental Information 2022). These trends will affect the probability and frequency of dry conditions that could lead to drought events in Hudson County.

7.1.6 Cascading Impacts on Other Hazards

Drought increases conditions that may trigger fires in the County, such as dead and dying trees, and grasses. Drought can lead to increasing temperatures and evaporation of moisture, which are ideal dry conditions for wildfire events to occur. Dry, hot, and windy weather combined with dry vegetation makes some areas more susceptible to sparking wildfires when met with a spark created by humans or natural events, including lightning. Additionally, droughts can lead to the following (NIDIS 2019):

- Long-term damage to crop quality and crop losses.
- Insect infestation leading to crop losses and reduced tree canopy.
- Reduction in the ability to perform outdoor activities, which could result in loss of tourism and recreation opportunities.

7.2 Vulnerability and Impact Assessment

To understand risk, a community must evaluate assets exposed and vulnerable within the identified hazard area. For the drought hazard, all Hudson County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities, and lifelines) described in the County Profile (Chapter 3) are potentially vulnerable to a drought. The following text provides a qualitative evaluation of the potential impact of the drought hazard on the county.

7.2.1 Life, Health, and Safety

The entire population of Hudson County (724,854) is exposed to drought events. Drought conditions can cause a shortage of potable water for human consumption, both in quantity and quality. A decrease in available water may also impact power generation and availability to residents.

Overall Population

Public health impacts may include an increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Vulnerable populations could be particularly susceptible to the drought hazard and cascading impacts due to age, health conditions, and limited ability to mobilize to shelter, cooling and medical resources. Other possible impacts to health due to drought include increased recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Some drought-related health effects are short-term while others can be long-term (Centers for Disease Control and Prevention 2021).

Drought affects groundwater sources, but generally not as quickly as surface water supplies. Groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams also. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest (New Jersey Department of Environmental Protection 2021).

Socially Vulnerable Population

Socially vulnerable populations are most susceptible to drought events based on several factors, including their physical and financial ability to react or respond during a drought. Vulnerable populations include homeless persons, elderly (over 65 years old), low income or linguistically isolated populations, people with life-threatening illnesses, and residents that may have limited access to water as is. The population over the age of 65 is also more vulnerable. They may require extra water supplies or need assistance to obtain water and are more likely to seek or need medical attention.

Without a quantitative assessment of potential impacts of a drought 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 Hudson County. Section 3.6.4 provides detailed data on socially vulnerable populations within the planning area. Table 7-6 summarizes highlights of this information. For planning purposes, it is reasonable to assume that percentages and distribution of socially vulnerable populations affected by a drought will be similar to the countywide numbers.

Table 7-6. Distribution of Socially Vulnerable Populations by Municipality

Category	Countywide Total		Municipality Highest in Category		Municipality Lowest in Category	
	Number	Percent	Number	Percent	Number	Percent
Population Over 65	**86,664**	**12.0%**	Jersey City 32,671	North Bergen **16.6%**	East Newark **308**	Hoboken **6.4%**
Population Under 5	**86,664**	**12.0%**	Jersey City 20,476	Bayonne **7.1%**	East Newark **106**	East Newark **4.1%**
Non-English-Speaking Population	**93,494**	**12.9%**	Jersey City 29,070	West New York **24.5%**	East Newark **474**	Hoboken **4.3%**
Population With Disability	**61,174**	**8.4%**	Jersey City 22,396	Union City **11.2%**	East Newark **209**	Weehawken **6.2%**
Population Below Poverty Level	**99,546**	**13.7%**	Jersey City 43,134	East Newark **24.6**	East Newark **638**	Seacaucus **5.1%**
Households Below ALICE Threshold	**63,893**	**21%**	Jersey City **119,278**	Union City **49%**	East Newark **846**	Hoboken **20%**

7.2.2 General Building Stock

No structures are anticipated to be directly affected by a drought event. However, droughts contribute to conditions conducive to wildfires and reduce fire-fighting capabilities. Risk to life and property is greatest in those areas where

forested areas adjoin urbanized areas (high density residential, commercial, and industrial) also known as the wildland-urban interface or where areas are made up of species that are highly susceptible to erupting into wildfire events. Therefore, all assets in and adjacent to the wildland-urban interface zone and wildfire fuel hazard areas, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Refer to Chapter 13 for the Wildfire risk assessment.

7.2.3 Community Lifelines and Other Critical Facilities

As mentioned, drought events generally do not impact buildings; however, droughts have the potential to impact agriculture-related facilities, critical facilities, and lifelines that are associated with water supplies such as potable water used with fire-fighting services. Critical facilities and lifelines in and adjacent to the wildfire hazard areas are also considered vulnerable to drought.

Water systems and thus distribution to the population may also be impacted by drought conditions. The County's water supply sources are from surface water and unconfined groundwater sources (New Jersey Department of Environmental Protection 2022). In terms of annual water withdrawal by sector, the second highest sector is potable water supply. Water use trends, like withdrawal trends, vary from month to month with water use typically peaking during summer months when outdoor and irrigation demands are high (United States Environmental Protection Agency 2010).

7.2.4 Economy

Drought can produce a range of impacts that span many economic sectors and can reach beyond an area experiencing physical drought. As previously discussed, water withdrawals are not only used for potable water but for use in the commercial/industrial/mining sectors and power generation. When a state of water emergency is declared by the Governor (when a potential or actual water shortage endangers the public health, safety, and welfare), the NJDEP may impose mandatory water restrictions and require specific actions to be taken by water suppliers. According to the New Jersey Water Supply Plan, a water emergency seeks to cause as little disruption as possible to commercial activity and employment (New Jersey Department of Environmental Protection 2017).

A prolonged drought can have a serious economic impact on a community. When drought conditions persist with little to no relief, water restrictions may be put into place by local or state governments. These restrictions may include placing limitations on when or how frequent lawns can be watered, car washing services, or any other recreational/commercial outdoor use of water supplies. In exceptional drought conditions, watering of lawns and crops may not be an option. If crops are not able to receive water, farmland will dry out and crops will die. This can lead to crop shortages, which, in turn, increases the price of food (North Carolina State University 2013).

Increased demand for water and electricity can also result in shortages and higher costs for these resources. Industries that rely on water for business could be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant within the recreation and tourism industry. Moreover, droughts within another area could impact the food supply and price of food for residents within the county.

7.2.5 Natural, Historic and Cultural Resources

NATURAL

Droughts can exacerbate conditions conducive to wildfires, increase insect infestations, and exacerbate the spread of disease (Intergovernmental Panel on Climate Change 2016). Droughts will also impact water resources that are relied upon by aquatic and terrestrial species. Ecologically sensitive areas, such as wetlands, can be particularly vulnerable to drought periods because they are dependent on steady water levels and soil moisture availability to sustain growth (New Jersey Department of Environmental Protection 2017).

If water is not getting into the soils, the ground will dry up and become unstable. Unstable soils increase the risk of erosion and loss of topsoil. Droughts also have the potential to lead to water pollution due to the lack of rainwater to dilute any chemicals in water sources. Contaminated water supplies may be harmful to plants and animals (North Carolina State University 2013).

Drought affects groundwater sources, but generally not as quickly as surface water supplies. Groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels. Reduced replenishment of groundwater affects streams also. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest (NJDEP 2021).

HISTORIC

The primary impacts on historic resources from drought would be an increased risk of wildfires, which could threaten these assets, and impacts on structure foundations from the shrink-swell cycle of expansive soils.

CULTURAL

Prolonged drought and seasonal aridity can exacerbate soil deflation and erosion, potentially uncovering previously buried archaeological sites (USDA Forest Service 2018). This exposure increases the vulnerability of these sites to further damage and loss, posing a significant threat to the preservation of cultural heritage.

7.3 Future Changes That May Affect Risk

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

7.3.1 Potential or Planned Development

As discussed in Chapter 3 (County Profile), areas targeted for future growth and development have been identified across Hudson County. Development and urbanization reduce natural landscapes that help recharge groundwater and

maintain ecological balance, further reducing water availability during droughts. The New Jersey Water Supply Plan indicates seasonal outdoor water use is rising statewide and is attributable to continued suburbanization and increases in residential and commercial lawn and landscape maintenance. Changes in water demands by commercial/industrial users will depend on future development of this water type use and how effectively efficiency techniques are implemented (New Jersey Department of Environmental Protection 2017).

7.3.2 Projected Changes in Population

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

Projected population increases can intensify the impacts of drought in several ways. A larger population will lead to higher demand for water for residential, agricultural, and industrial uses, making management during drought conditions more challenging (NEEF 2024). This increased demand will also put additional pressure on water infrastructure, leading to more frequent breakdowns and maintenance issues, complicating water distribution. With more people relying on the same water sources, the risk of water shortages during prolonged dry periods increases, leading to stricter water use restrictions and competition for limited resources.

Higher population density can also increase the risk of wildfires, as more human activity can lead to accidental fires, which are exacerbated by drought conditions, leading to more frequent and severe wildfires that threaten both natural and developed areas (WRI 2024). Overall, the projected population growth in Hudson County will likely intensify the challenges associated with managing water resources and mitigating the impacts of drought. Refer to Chapter 3 (County Profile), which includes a more thorough discussion about population trends for the County.

7.3.3 Climate Change

Most studies project that New Jersey will experience more frequent droughts, which may affect the availability of water supplies, primarily placing an increased stress on the population and their available potable water. Agricultural needs may increase if the climate grows warmer but may decrease if more efficient irrigation techniques are adopted broadly or if precipitation increases. A decrease in water supply, or increase in water supply demand, may increase the County's vulnerability to structural fire and wildfire events. Critical water-related service sectors may need to adjust management practices and actively manage resources to accommodate future changes.

7.3.4 Other Identified Conditions

As mentioned previously, resources indicate that New Jersey will experience a rise in average annual temperatures. Furthermore, there is a projected increase in the occurrence of droughts, which could impact the availability of water supplies and place added strain on the population and their access to clean drinking water. A decrease in water supply, or an increase in demand for water, may heighten the County's susceptibility to structural fires and wildfires. Consequently, it may be necessary for critical water-related service sectors to modify their management strategies and proactively allocate resources to adapt to forthcoming shifts.