4.3 HAZARD PROFILES

4.3.1 Dam Failure

2024 HMP Changes

- Dam failure has been removed from the flood hazard profile and is now a stand-alone hazard of concern.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2018 and 2023.

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the dam failure hazard in Burlington County.

Hazard Description

A dam is a structure built across a river or stream to hold back water. The materials used for construction of dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, miscellaneous materials (such as plastic or rubber) and any combination of these materials. The purpose of a dam is to store water, wastewater, or liquid borne materials for several reasons, including flood control, human water supply, energy generation, recreation, or pollution control. Many dams fulfill a combination of the above functions. Dams require regular maintenance to retain their level of protection. When dams fail or overtop, they can cause catastrophic impacts and lead to major flooding and impacts (Association of State Dam Safety Officials 2023).

Dam failures occur when the dam is damaged or destroyed, releasing water or other liquid stored behind the dam. Throughout history, hundreds of dams failed in the United States, causing property and environmental damage, injuries, and fatalities. According to the Association of State Dam Safety Officials, dam failures are most likely to occur as a result of the following:

- Overtopping caused by water spilling over the top of a dam.
- Foundation defects, including settlement and slope instability.
- Cracking caused by movement.
- Inadequate maintenance and upkeep.
- Seepage through a dam that is not properly filtered so that soil particles form sinkholes in the dam (Association of State Dam Safety Officials 2021).

Despite efforts to provide sufficient structural integrity and to perform inspection and maintenance, problems can develop that lead to failure. While most dams have storage volumes small enough that failures would have little or no consequences, dams with large storage amounts could cause significant flooding downstream (FEMA 2013).

Location

According to NJDEP, Burlington County has 74 dams. Of these dams, 10 are considered high hazard, 40 are considered significant hazard, and 24 are considered low hazard (USACE 2023).

In addition to dams located within the County, there are multiple dams that are located in neighboring counties that could impact Burlington County if failure occurs. The County might require emergency action plans for these respective dams for the various communities that might be affected. Table 4.3.1-1 lists these dams.

Table 4.3.1-1. Dams in Neighboring Counties

Dam Name	Dam Location	Classification
Pleasant Milles Dam	Mullica, Atlantic County	Significant
Cedar Lake Dam	Voorhees, Camden County	Significant
Sunshine Lake Dam	Voorhees, Camden County	Significant
Gropps Lake Dam	Hamilton, Mercer County	Low
Oakford Lake Dam	New Egypt, Ocean County	Low
Brindle Lake Dam	Plumsted, Ocean County	Low
New Jersey No Name #101 Dam	Manchester, Ocean County	Low
Gaunts Reservoir Dam	Manchester, Ocean County	Low
Prospertown Dam	Jackson, Ocean County	High
Lahaway Plantation Dam	Jackson, Ocean County	Low

Source: USACE 2023

Extent

The extent or magnitude of a dam failure event can be measured in terms of the classification of the dam. Additionally, there are two factors that influence the potential severity of a full or partial dam failure; (1) the amount of water impounded; and (2) the density, type, and value of development and infrastructure located downstream (FEMA 2018).

FEMA, USACE, and NJDEP all have classification systems for dams. Please refer to *Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams* (2004) and *Safety of Dams – Police and Procedures* (2014) for an explanation of the FEMA and USACE classifications.

The New Jersey Department of Environmental Protection (NJDEP) assigns one of four hazard classifications to state-regulated dams in New Jersey. The classifications relate to the potential property damage and/or loss of life in the event of a dam failure, as follows (NJDEP 2008):

- Class I (High-Hazard Potential)—Failure of the dam may result in probable loss of life and/or extensive property damage.
- Class II (Significant-Hazard Potential)—Failure of the dam may result in significant property damage; however, loss of life is not envisioned.
- Class III (Low-Hazard Potential)—Failure of the dam is not expected to result in loss of life and/or significant property damage.
- Class IV (Zero-Hazard Potential)—Failure of the dam is not expected to result in loss of life or significant property damage. Dam must also meet the requirements of a Class IV dam above.

It is required by the State of New Jersey that all High Hazard and Significant Hazard dams must have NJDEP-approved Emergency Action Plans (EAP) in place. It is the responsibility of the dam owner to review and update the EAP on an annual basis. The State also requires regular dam inspections. Dam Safety Inspections are intended to identify conditions that may adversely affect the safety and functionality of a dam and its appurtenant structures; to note the extent of deterioration as a basis for long term planning, periodic maintenance, or immediate repair; to evaluate conformity with current design and construction practices; and to determine the appropriateness of the existing hazard classification. Inspection guidelines are summarized in Table 4.3.1-2. Complete inspection and operating requirements for dams can be found in the New Jersey Dam Safety Standards (N.J.A.C. 7:20-1.11) (NJDEP 2008).

Table 4.3.1-2. New Jersey Dam Inspection Requirements

Dam Size/Type	Regular Inspection	Formal Inspection
Class I (High Hazard) Large Dam	Annually	Once every 3 years
Class I (High Hazard) Dam	Once every 2 years	Once every 6 years
Class II (Significant Hazard) Dam	Once every 2 years	Once every 10 years
Class III (Low Hazard) Dam	Once every 4 years	Only as required
Class IV (Zero Hazard) Dam	Once every 4 years	Only as required

Source: NJDEP 2008

NJDEP has set guidelines to meet the requirements of the National Inventory of Dams condition assessment of existing dams. Table 4.3.1-3 lists definitions for each potential deficiency rating.

In New Jersey, every dam in the State as defined in the Safe Dam Act, NJSA 58:4 is required to meet State dam safety standards. Dam Safety Laws provide the NJDEP with enforcement capabilities to achieve statewide compliance with dam safety standards. This includes issuing orders for compliance to dam owners, and pursuing legal action if the owner does not comply (with the goal of compliance and possible fines levied on a per-day basis for violations) (NJDEP 2023).

Table 4.3.1-3. New Jersey Dam Inspection Deficiency Ratings

Rating	Definition
Satisfactory	No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all applicable loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria. Minor maintenance items may be required.
Fair	Acceptable performance is expected under all required loading conditions (static, hydrologic, seismic) in accordance with the applicable dam safety regulatory criteria. Minor deficiencies may exist that require remedial action and/or secondary studies or investigations.
Poor	A dam safety deficiency is recognized for any required loading condition (static, hydrologic, seismic) in accordance with the applicable dam safety regulatory criteria. Remedial action is necessary. POOR also applies when further critical studies or investigations are needed to identify any potential dam safety deficiencies.
Unsatisfactory	Considered unsafe. A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution. Reservoir restrictions may be necessary.

Source: NJDEP 2017

Previous Occurrences and Losses

Historical information regarding previous occurrences and losses associated with flood events throughout New Jersey and areas within Burlington County was obtained from many sources. Given so many sources reviewed for the purpose of this HMP, loss and impact information regarding many events could vary depending on the source.

FEMA Major Disasters and Emergency Declarations

Between May 1953 and June 2023, FEMA has not included New Jersey, or consequently Burlington County, in any dam failure-specific disasters (DR) or emergencies (EM). However, dam-failures have occurred due to other precursor events, such as hurricanes, tropical storms, and severe storms (FEMA 2023). These events are listed in Table 4.3.1-4. Multiple dam failures occurred in Burlington County associated with DR-1530-NJ, as further described below.

Table 4.3.1-4. FEMA Declarations for Dam Failure Events in Burlington County

FEMA Declaration Number	Date of Declaration	Date of Event	Event Type	Event Title
EM-3148-NJ	September 17, 1999	September 16 – 18, 1999	Hurricane	New Jersey Hurricane Floyd
DR-1530-NJ	July 16, 2004	July 12 – 23, 2004	Severe Storm	New Jersey Severe Storms and Flooding
EM-3332-NJ	August 27, 2011	August 26 – September 5, 2011	Hurricane	Hurricane Irene in New Jersey
DR-4021-NJ	August 31, 2011	August 27 – September 5, 2011	Hurricane	Hurricane Irene in New Jersey

Source: FEMA 2023

U.S. Department of Agriculture Disaster 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 counties that are contiguous to a designated county. Between August 2018 and June 2023, Burlington County was not included in any dam failure-related agricultural disaster declarations (USDA 2023).

Previous Events

As stated in the 2019 New Jersey State HMP Update, dam failures can occur suddenly, without warning, and may occur during normal operating conditions. This is referred to as a “sunny day” failure. Dam failures may also occur during a large storm event. Significant rainfall can quickly inundate an area and cause floodwaters to overwhelm a reservoir. If the spillway of the dam cannot safely pass the resulting flows, water will begin flowing in areas not designed for such flows, and a failure may occur. New Jersey has seen significant property damage including damage or loss of dams, bridges, roads, and buildings as a result of storm events and dam failures (NJOEM 2019).

In September 1940, torrential rains caused flooding, leading to dam failures at Taunton and Medford Lakes in Lumberton Township (FEMA 2019).

On September 16, 1999, Hurricane Floyd, a tropical storm by the time it hit New Jersey, combined with a weather system from the west to drop significant rainfall in portions of the State. Although the State’s dams were spared the worst and no loss of life or significant property damage was attributed to the failure of a dam, the storm left behind a trail of damage to the State’s dams. The Kirby’s Mill Dam in Medford Township, Burlington County experienced a complete failure as a result of the storm (NJOEM 2019).

On July 12-13, 2004, the Townships of Lumberton and Medford experienced major flooding due to heavy rainfall. 17 dams failed and 28 more dams were damaged along various streams (FEMA 2019). Doppler radar estimates of total rainfall for the 24-hour period ending at 5:00PM on July 13, 2004, were between 8-12 inches. Property damage from the flood was estimated at $50 million. The flooding led to the evacuation of about 760 residents, the complete destruction of seven homes, major flood damage to approximately 200 homes, flood damage to approximately

1,000 homes, the closing of 25 major roads, (including the New Jersey Turnpike and New Jersey State Routes 70 and 73), and serious damage or destruction to 14 bridges (NJDEP 2020).

Rainfall totaling as much as 10 inches fell during August 27–28, 2011 and, combined with wet conditions caused by 8 to 16 inches of rain statewide during the 3 weeks preceding Hurricane Irene, set the stage for record-breaking floods on many streams in New Jersey. NJDEP reported the failure of six dams as a result of Hurricane Irene, including the New Jersey No Name # 89 Dam. This dam, which had failed completely, is located on a tributary to Crosswicks Creek in North Hanover Township in Burlington County upstream from the gage on Crosswicks Creek at Extonville (USGS 2011).

There have been no recorded dam failures in, or which have impacted, the County since the last HMP update in 2019. (Association of State Dam Safety Officials 2021); (Stanford University 2018)

Probability of Future Occurrence

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides, and excessive rainfall or snowmelt. As noted in the *Previous Occurrences and Losses* section, dam failures typically occur in New Jersey as a result of heavy rains or other precipitation. There is a "residual risk" associated with dams. Residual risk is the risk that remains after safeguards have been implemented. For dams, the residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of any type of dam failure is low in today's dam safety regulatory and oversight environment (NJOEM 2019).

For the 2024 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of dam failure events for the County. Information from Stanford University's National Performance of Dams Program database, Association of State Dam Safety Official's Dam Incident Database, NOAA-NCEI storm events database, the County FIS Report, the 2019 State of New Jersey HMP, and the 2019 Burlington County HMP were used to identify the number of flood events that occurred between January 1950 and May 2023. Table 4.3.1-5 presents the probability of future events for dam failure in Burlington County.

Table 4.3.1-5. Probability of Future Occurrences of Dam Failure Events

Hazard Type	Occurrences Between 1940 and 2023	% Chance of Occurring in Any Given Year	Recurrence Interval (in years) (# Years/Number of Events)
Dam Failure	21	25.3%	3.95
Total	**21**	**25.3%**	**3.95**

Source: NOAA 2023; FEMA 2019; Association of State Dam Safety Officials 2021; Burlington County 2019; Stanford University 2018; NJOEM 2019

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all dam failure events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for the County were ranked (Table 4.4-2). 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 Team, the probability of occurrence rating for dam failure in the County is "rare."

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, which is faster than the rest of the Northeast region (2 °F [1.1 °C]) and the world (1.5 °F [0.8 °C]). 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). 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). 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. 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. Changes in winter temperatures could result in a change in the frequency of ice jam events (NJDEP 2020).

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. 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. By the end of this century, heavy precipitation events are projected to occur two to five times more often and with more intensity than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls. Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts. New Jersey could also experience an increase in the number of flood events (NJDEP 2020).

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

Climate change can impact stored water systems as increased rainfall accumulations can cause reservoirs to overtop. Dams are designed using a hydrograph to evaluate dam safety issues for situations where the reservoir inflow peak discharge is greater than the maximum spillway capacity, the reservoir has large surcharge storage, and/or the reservoir has dedicated flood control space. Increased precipitation may result in overtopping, as the hydrographs are based off historical events (USBR 2003). The overtopping of a dam can lead to areas downstream to become inundated with flood waters that would otherwise be safely stored.

Vulnerability Assessment

The dam failure hazard is of significance to Burlington County because 74 dams are present across the County, 10 of which are identified as high hazard (Table 4.3.1-1) (USACE 2023). Dam failure events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard.

Dam failure inundation maps and downstream hazard areas are considered sensitive information and are not made available in the Burlington County Hazard Mitigation Plan. To assess the County's risk from dam failure, a qualitative review was implemented.

Impact on Life, Health, and Safety

The impact of dam failure on life, health, and safety is dependent on several factors such as the class of dam, the area that the dam is protecting, the location of the dam, and the proximity of structures, infrastructure, and critical facilities to the dam structure. According to the State HMP, the level of impact that a failure would have can be predicted based upon the hazard potential classification as rated by the United States Army Corps of Engineers (USACE 2014). Table 4.3.1-6 outlines the recommended hazard classifications.

Table 4.3.1-6. U.S. Army Corps of Engineers Hazard Potential Classification

Hazard Category[a]	Direct Loss of Life[b]	Lifeline Losses[c]	Property Losses[d]	Environmental Losses[e]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

Source: USACE 2014

a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss-of-life potential is based on inundation mapping of area downstream of the project. Analyses of loss-of-life potential should consider the population at risk, time of flood wave travel, and warning time.
c. Lifeline losses include indirect threats to life caused by the interruption of lifeline services from project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Property losses include damage to project facilities and downstream property and indirect impact from loss of project services, such as impact from loss of a dam and navigation pool, or impact from loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Socially Vulnerable Populations

The entire population residing within a dam failure inundation zone is considered exposed and vulnerable to an event. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living within these areas. Those most at risk include the economically disadvantaged and the population over the age of 65.

According to the 2021 5-year ACS estimates, there are 27,947 total persons living below the poverty level, 78,093 persons over the age of 65 years, 23,350 persons under the age of 5 years, 9,103 non-English speakers, and 51,899 persons with a disability in Burlington County. These populations are more at risk during a dam failure event because economically disadvantaged populations are likely to evaluate their risk and make the decision to evacuate based upon the net economic impact to their family, while elderly populations are likely to seek or need medical attention. The availability of medical attention may be limited due to isolation during a flood event and other difficulties in evacuating. There is often limited warning time for a dam failure event. Populations without adequate warning of the event are highly vulnerable.

As shown in Table 4.3.1-7, Evesham Township has the highest population over 65 (8,574) and highest population under the age of 5 (2,237). Pemberton Township has the largest population of non-English speaking persons (1,092). Willingboro Township has the greatest population of individuals living in poverty (2,685) and the largest disabled population (5,100). Wrightstown Township has the lowest population over 65 (58). Washington Township has the lowest population of individuals under the age of 5 (8). Bass River Township, Beverly City, Eastampton Township, Fieldsboro Borough, Medford Lakes Borough, Shamong Township, and Woodland Township all have no (0) non-English speaking persons living within the jurisdiction. Fieldsboro Borough has fewest number of disabled persons in their jurisdiction (62). Wrightstown Borough has the lowest population living in poverty (21).

Dam failure can cause persons to become displaced if flooding of structures occurs. Dam failure may mimic flood events, depending on the size of the dam reservoir and breach. Understanding potential outcomes of flooding for each dam in Burlington County would require intensive hydraulic modeling.

Table 4.3.1-7. Burlington County Socially Vulnerable Populations by Municipality

Jurisdiction[a]	Decennial Population 2020		American Community Survey 5-Year Population Estimates (2021)									
			Population Over 65		Population Under 5		Non-English Speaking Population		Population with Disability		Population Below Poverty Level	
	Jurisdiction Total	% of County Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total
Bass River (T)	1,355	0.3%	248	18.3%	67	4.9%	0	0.0%	175	12.9%	95	7.0%
Beverly (C)	2,499	0.5%	292	11.7%	183	7.3%	0	0.0%	249	10.0%	300	12.0%
Bordentown (C)	3,993	0.9%	772	19.3%	216	5.4%	16	0.4%	422	10.6%	227	5.7%
Bordentown (T)	11,791	2.6%	1,601	13.6%	472	4.0%	289	2.4%	1,092	9.3%	194	1.6%
Burlington (C)	9,743	2.1%	1,301	13.4%	661	6.8%	208	2.1%	1,251	12.8%	1,422	14.6%
Burlington (T)	23,983	5.2%	3,526	14.7%	1,497	6.2%	385	1.6%	2,366	9.9%	2,185	9.1%
Chesterfield (T)	9,422	2.0%	760	8.1%	578	6.1%	153	1.6%	423	4.5%	165	1.8%
Cinnaminson (T)	17,064	3.7%	3,103	18.2%	929	5.4%	208	1.2%	1,661	9.7%	584	3.4%
Delanco (T)	4,824	1.0%	1,297	26.9%	191	4.0%	42	0.9%	676	14.0%	322	6.7%
Delran (T)	17,882	3.9%	2,570	14.4%	1,047	5.9%	723	4.0%	1,548	8.7%	902	5.0%
Eastampton (T)	6,191	1.3%	557	9.0%	264	4.3%	0	0.0%	478	7.7%	488	7.9%
Edgewater Park (T)	8,930	1.9%	1,571	17.6%	700	7.8%	367	4.1%	1,465	16.4%	1,645	18.4%
Evesham (T)	46,826	10.1%	8,574	18.3%	2,237	4.8%	749	1.6%	4,504	9.6%	1,476	3.2%
Fieldsboro (B)	526	0.1%	82	15.6%	64	12.2%	0	0.0%	62	11.8%	36	6.8%
Florence (T)	12,812	2.8%	2,122	16.6%	645	5.0%	260	2.0%	1,460	11.4%	827	6.5%
Hainesport (T)	6,035	1.3%	1,327	22.0%	58	1.0%	0	0.0%	744	12.3%	250	4.1%
Lumberton (T)	12,803	2.8%	2,048	16.0%	661	5.2%	107	0.8%	1,490	11.6%	805	6.3%
Mansfield (T)	8,897	1.9%	2,506	28.2%	394	4.4%	330	3.7%	1,465	16.5%	181	2.0%
Maple Shade (T)	19,980	4.3%	2,897	14.5%	1,159	5.8%	694	3.5%	2,433	12.2%	1,971	9.9%
Medford (T)	24,497	5.3%	5,151	21.0%	1,085	4.4%	31	0.1%	2,775	11.3%	724	3.0%
Medford Lakes (B)	4,264	0.9%	879	20.6%	211	4.9%	0	0.0%	407	9.5%	26	0.6%
Moorestown (T)	21,355	4.6%	3,480	16.3%	837	3.9%	603	2.8%	1,654	7.7%	807	3.8%
Mount Holly (T)	9,981	2.2%	1,199	12.0%	454	4.5%	133	1.3%	1,624	16.3%	958	9.6%
Mount Laurel (T)	44,633	9.7%	8,299	18.6%	2,011	4.5%	889	2.0%	4,203	9.4%	1,689	3.8%
New Hanover (T)	6,367	1.4%	311	4.9%	214	3.4%	29	0.4%	192	3.0%	116	1.8%
North Hanover (T)	7,963	1.7%	532	6.7%	975	12.2%	125	1.6%	631	7.9%	481	6.0%
Palmyra (B)	7,438	1.6%	1,077	14.5%	190	2.6%	44	0.6%	961	12.9%	616	8.3%
Pemberton (B)	1,371	0.3%	282	20.6%	56	4.1%	47	3.4%	308	22.5%	140	10.2%

Jurisdiction[a]	Decennial Population 2020		American Community Survey 5-Year Population Estimates (2021)									
			Population Over 65		Population Under 5		Non-English Speaking Population		Population with Disability		Population Below Poverty Level	
	Jurisdiction Total	% of County Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total
Pemberton (T)	26,903	5.8%	4,306	16.0%	1,429	5.3%	1,092	4.1%	4,006	14.9%	2,518	9.4%
Riverside (T)	8,003	1.7%	1,039	13.0%	354	4.4%	754	9.4%	972	12.1%	1,257	15.7%
Riverton (B)	2,764	0.6%	554	20.0%	80	2.9%	5	0.2%	187	6.8%	72	2.6%
Shamong (T)	6,460	1.4%	1,313	20.3%	324	5.0%	0	0.0%	671	10.4%	136	2.1%
Southampton (T)	10,317	2.2%	3,153	30.6%	293	2.8%	125	1.2%	1,551	15.0%	589	5.7%
Springfield (T)	3,245	0.7%	479	14.8%	129	4.0%	65	2.0%	311	9.6%	160	4.9%
Tabernacle (T)	6,776	1.5%	1,524	22.5%	380	5.6%	0	0.0%	747	11.0%	233	3.4%
Washington (T)	693	0.2%	138	19.9%	8	1.2%	8	1.1%	87	12.6%	21	3.0%
Westampton (T)	9,121	2.0%	1,139	12.5%	263	2.9%	81	0.9%	802	8.8%	268	2.9%
Willingboro (T)	31,889	6.9%	5,707	17.9%	1,916	6.0%	538	1.7%	5,100	16.0%	2,685	8.4%
Woodland (T)	1,544	0.3%	319	20.7%	49	3.2%	0	0.0%	627	40.6%	363	23.5%
Wrightstown (B)	720	0.2%	58	8.1%	69	9.6%	5	0.7%	119	16.5%	13	1.8%
Burlington County Total	**461,860**	**100.0%**	**78,093**	**16.9%**	**23,350**	**5.1%**	**9,103**	**2.0%**	**51,899**	**11.2%**	**27,947**	**6.1%**

Source: U.S. Census Bureau 2020, 2021

Note: Persons per household = 2.6

a. (B) = borough; (C) = city; (T) = township

Impact on General Building Stock

Buildings located downstream of a dam are at risk of damage should there be a failure. Downstream inundation areas were not available to quantify any potential losses to structures. Properties located closest to the dam inundation area have the greatest potential to experience the largest, most destructive surge of water. The overall impact of flooding damage caused by dam failure will vary depending on the depth of flooding and velocity of the surge.

Impact on Critical Facilities

Dam failures may also impact critical facilities and lifelines located in the downstream inundation zone. Consequentially, dam failure can cut evacuation routes, limit emergency access, and/or create isolation issues. Dam failure can cause severe downstream flooding and may transport large volumes of sediment and debris, depending on the magnitude of the event. Widespread damage to buildings and infrastructure affected by an event would result in large costs to repair these locations. In addition to physical damage costs, businesses can be closed while flood waters retreat and utilities are returned to a functioning state. Further, utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

Impact on Economy

Severe flooding that follows an event like a dam failure can cause extensive structural damage and withhold essential services. The cost to recover from flood damage after a surge will vary depending on the hazard risk of each dam. The 2019 State HMP discusses damage from dam failures ranging from $7 million to $25 million as a result of previous events in the State. This cost likely varies because of the density of structures and businesses that surround the protected area (NJOEM 2019).

Severe flooding that follows an event like a dam failure can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities can become temporarily out of operation. Debris from surrounding buildings can accumulate should the dam mimic major flood events, such as the 1-percent annual chance flood event that is discussed in Section 4.3.6 (Flood).

Based on existing data, given the County's higher density along the Delaware River, potential damage might cascade from upstream of hazardous dams, namely the Atsion Lake, Timber Lake, Sylvan Lake, Centennial Lake, Mirror Lake, Mishe-Mokwa, Vincentown Mill, Ballinger Lake, Smithville, and Wagush Dams which are all ranked as high hazard dams (USACE 2023).

Impact on Environment

The environmental impacts of a dam failure can include significant water-quality and debris-disposal issues or severe erosion that can impact local ecosystems. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooded waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals may be added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties.

Cascading Impacts on Other Hazards

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat. Dam failures can occur as a result of structural failures, such as progressive erosion of an embankment or overtopping and breaching by a severe flood. Earthquakes may weaken dams. Floods caused by dam failures have caused loss of life and property damage (FEMA 2013).

Further Changes that May Impact Vulnerability

Understanding future changes that may 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 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

As discussed, and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by a dam failure event if the structures are located within the flood protection area and mitigation measures are not considered. Therefore, it is the intention of the County and all participating municipalities to discourage development in vulnerable areas or to encourage higher regulatory standards at the local level. Due to the sensitive nature of dam locations and downstream inundation zones, an assessment to determine the proximity of these new development sites to potential dam inundation cannot be performed at this time.

Projected Changes in Population

Burlington County has experienced an increase in its population since 2010. According to the U.S. Census Bureau, the County's population increased by approximately 3 percent between 2010 and 2020 (U.S. Census Bureau 2020). 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, Burlington County is projected to have a population of 460,400 by 2024, 464,900 by 2029, and 472,700 by 2034 (State of New Jersey 2017). As the population increases any changes in the density of population can impact the number of persons exposed to the probable maximum flood inundation hazard areas. Higher density can not only create issues for local residents during evacuation of a dam failure event but can also have an effect on commuters that travel into and out of the County for work, particularly during a flood event that may impact transportation corridors, which are also major commuter roads. Refer to Section 3 (County Profile) for more information about population trends in the County.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual precipitation. Annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to increase the risk of dam failures. Increases in precipitation may stress the structures. Further, existing flood control structures may not be able to retain and manage increases in water flow from more frequent, heavy rainfall events. Heavy rainfalls may result in more frequent overtopping of these dams and flooding of the County's assets in adjacent inundation areas. However, the probable maximum flood used to design each dam may be able to accommodate changes in climate.

Change of Vulnerability Since 2019 HMP

Overall, the County's vulnerability has not changed, and the County will continue to be exposed and vulnerable to dam failure events, especially those located within or near downstream inundation zones. Because of the sensitive nature of the dam failure inundation zones, potential losses have not been quantified and presented in this plan. To estimate potential losses to population, buildings, critical facilities and infrastructure, dam inundation areas and depths of flooding may be used to generate depth grids. Hazus may be used to estimate potential losses for the County and participating municipalities.