# 6. DAM FAILIURE

## 6.1 HAZARD PROFILE

### 6.1.1 Hazard Description

A dam is an artificial barrier allowing storage of water, wastewater, or liquid-borne materials for many reasons (flood control, human water supply, irrigation, livestock water supply, energy generation, containment of mine tailings, recreation, or pollution control). Many dams fulfill a combination of these stated functions (Association of State Dam Safety Officials n.d.). Water stored behind a dam represents potential energy that can endanger life and property located downstream. The risks that are associated with damns must be minimized at all times and maintained properly, including safety inspections, technical review of a proposed new dam, monitoring and enforcement of dam safety criteria, and emergency preparedness which is tracked by the New Jersey Department of Environmental Protection (NJDEP) within the Bureau of Dam Safety (NJDEP 2024).

Man-made dams can be classified according to the type of construction material used, methods applied in construction, slope, or cross-section of the dam, how a dam resists forces of water pressure behind it, means used to control seepage, and occasionally, the purpose of the dam. Materials used for the construction of dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, miscellaneous materials (plastic or rubber), and any combination of these materials (Association of State Dam Safety Officials n.d.). Dams are built for power production, agriculture, water supply, recreation, and flood protection. Dam failure is any malfunction or abnormality outside of the design that adversely affects a dam's primary function of impounding water and potentially leads to a sudden, rapid, and uncontrolled release of water (USSD 2023).

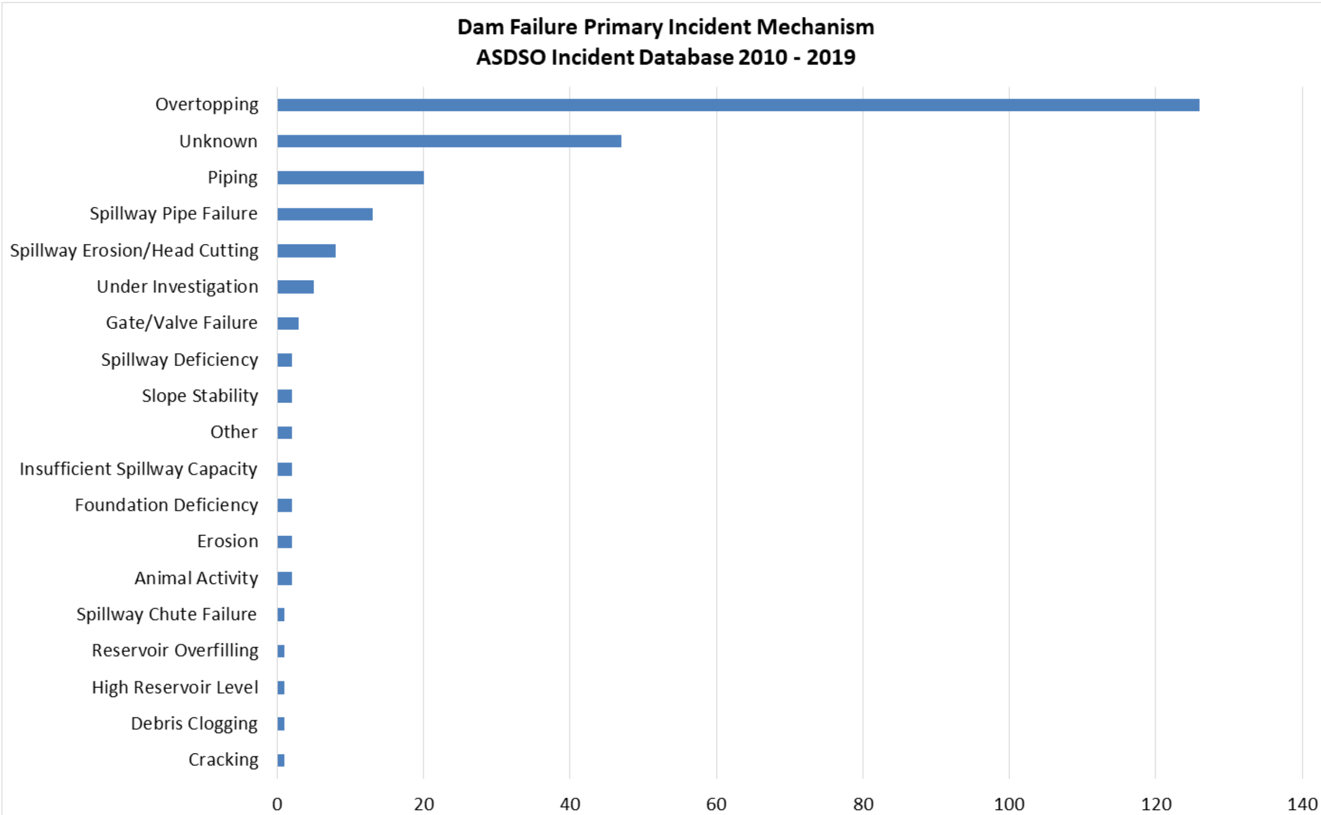
More than a third of the country’s dams are 50 or more years old. Approximately 15,000 of those dams pose a significant hazard to life and property if failure occurs. About 2,000 unsafe dams are dispersed throughout the United States in almost every state.

Dams typically fail when spillway capacity is inadequate, and excess flow overtops the dam or when internal erosion (piping) through the dam or foundation occurs. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-filled water that rushes downstream, damaging or destroying anything in its path (FEMA 2016).

Figure 6-1 visualizes the primary causes of dam failures nationally. Dam failures can result from one or a combination of the following (Association of State Dam Safety Officials n.d.):

- Overtopping caused by floods that exceed the capacity of the dam
- Deliberate acts of sabotage
- Structural failure of materials used in dam construction
- Movement or failure of the foundation supporting the dam
- Settling and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate maintenance and upkeep

Figure 6-1. Dam Failure Causes




*Source: Association of State Dam Safety Officials 2023*

## Regulatory Oversight of Dams

The potential for catastrophic flooding caused by dam failures led to the passage of the National Dam Safety Act (Public Law 92-367). For 30 years, the NDSP has protected Americans from dam failure. NDSP is a partnership among the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchase of needed equipment. FEMA has also expanded existing training programs and initiated new training programs. Grant assistance from FEMA provides support for the improvement of dam safety programs that regulate most dams in the United States (FEMA 2023).

New Jersey has a comprehensive dam safety program which is regulated by the New Jersey Department of Environmental Protection (NJDEP) within the Bureau of Dam Safety. The Bureau oversees the construction, repair, and inspection of dams to ensure safety and integrity of structure (NJDEP 2024).

Dam safety emergency action plans (EAP) are formal dam failure procedures written by the dam owner/operator. EAPs are site-specific plans and relate only to the facility's procedures to prevent/mitigate the occurrence of a catastrophic dam failure. USACE is responsible for submitting an EAP for each dam it owns, operates, and maintains. EAPs for hydroelectric dams fall under the purview of FERC, and NJDEP regulates dam safety and EAPs for all dams in the state (USACE 2014).

## New Jersey Department of Environmental Protection

The NJDEP Bureau of Dam Safety is responsible for safety inspection of dams, technical review of proposed dam construction or modification, monitoring of remedial work for compliance with dam safety criteria, and emergency preparedness for all dams in the state. The U.S. Army Corps of Engineers (USACE) flood control projects throughout the state are overseen by both the Philadelphia District and New York District of the USACE and are operated and maintained by NJDEP (in some cases with local municipal partners) (USACE n.d.).

The state generally inspects high-hazard (Class C) dams annually and moderate-hazard (Class B) dams every 2 years. All other low-hazard dams are inspected every 4 years. Inspections are typically conducted by NJDEP from March through December (N. J. NJDEP 2017). To support emergency planning efforts and raise awareness among local officials and emergency managers, a copy of each inspection report is sent to the chief executive of the community in which the dam is located. Municipal officials or emergency managers from any municipality in the dam's inundation area may receive a copy of the inspection report upon request (N. J. NJDEP 2017).

## U.S. Army Corps of Engineers Dam Safety Program

USACE is responsible for safety inspections of some federal and non-federal dams in the United States that meet size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams and has surveyed each state and federal agency's capabilities, practices, and regulations regarding the design, construction, operation, and maintenance of dams. USACE has also developed guidelines for inspection and evaluation of dam safety (HQ USACE 2021).

## Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. FERC cooperates with many federal and state agencies to ensure and promote dam safety and, more recently, homeland security. FERC staff inspect hydroelectric projects on an unscheduled basis to investigate the following (FERC 2023):

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with terms and conditions of a license

Every 5 years, an independent consulting engineer, approved by FERC, must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with a total storage capacity of more than 2,000 acre-feet (FERC 2023).

FERC monitors and evaluates seismic research in geographic areas where seismic activity is a concern. This information is applied to investigate and analyze structures of hydroelectric projects within these areas. FERC staff also evaluates the effects of potential and actual large floods on the safety of dams. FERC staff visit dams and licensed projects during and after floods, assess the extent of damage, and direct any studies or remedial measures the licensee must undertake. FERC's *Engineering Guidelines for the Evaluation of Hydropower Projects* guides FERC engineering staff and licensees in evaluations of dam safety. The publication is frequently revised to reflect current information and methodologies (FERC 2023).

FERC requires licensees to prepare Emergency Action Plans (EAP) and conducts training sessions on developing and testing these plans. The plans outline an early warning system in the event of an actual or potential sudden release of water from a dam failure. The plans include operational procedures that may be implemented during regulatory measures, such as reducing reservoir levels and downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that all applicable parties are informed of the proper procedures in emergencies (FERC 2023).

## 6.1.2 Location

A total of 11 dams are present throughout Cape May County. Most of these dams pose little risk; however, 7 of these dams are considered "significant hazard" dams and require an EAP. Table 6-1 is a complete list of dams in Cape May County (N. J. NJDEP 2024). The location of all dams in the County can be seen in Figure 6-2. Due to the lack of available spatial exposure data, the inundation areas for dams is assumed to be within the Special Flood Hazard Area.

Table 6-1. Dams in Cape May County

| Dam | River/Stream | Current Condition | Municipality |
|---|---|---|---|
| **Significant Hazard Dams** | | | |
| Magnolia Lake Dam | Mill Creek | Poor | Dennis Township |
| East Creek Pond Dam | East Creek | Fair | Dennis Township |
| West Creek Dam | West Creek | Fair | Dennis Township |
| Ludlam Pond Dam | Dennis Creek-TR | Poor | Dennis Township |
| Johnson Pond Dam | Dennis Creek-TR | Poor | Dennis Township |
| Nummytown Mill Pond Dam | Fishing Creek | Poor | Middle Township |
| Tarkiln Pond Dam | Tarkiln Run | Satisfactory | Upper Township |
| **Low Hazard Dams** | | | |
| Meisle (Nummy) Lake Dam | East Creek | N/A | Dennis Township |
| Beaver Club Dam | Dennis Creek | N/A | Middle Township |
| Tuckahoe Dam | Bog Branch Creek | N/A | Upper Township |
| New Jersey No Name # 123 Dam | Mill Creek | N/A | Upper Township |

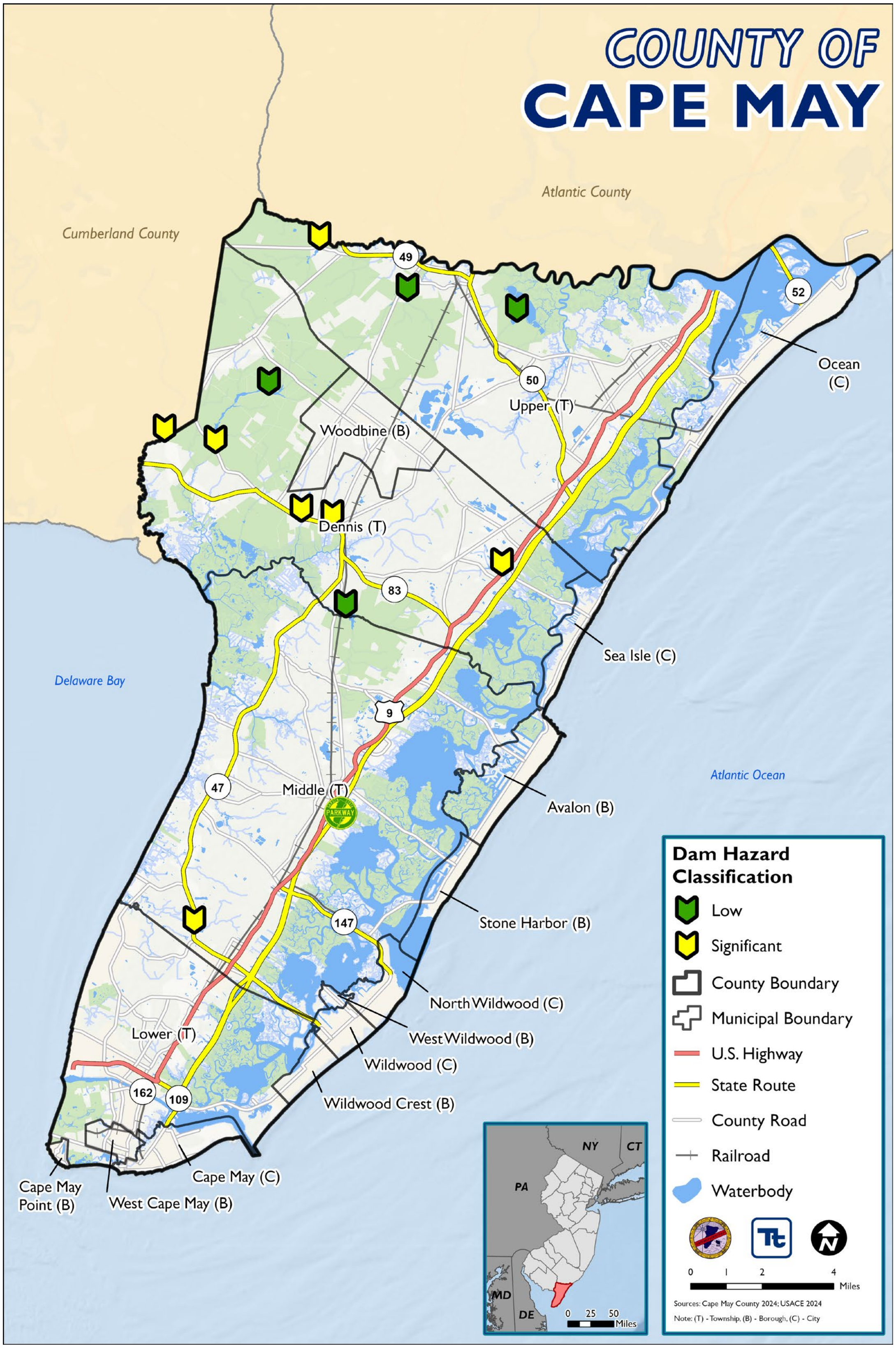
The USACE National Inventory of Dams (NID) provides the most recent dates of inspection of the following Cape May County dams in Table 6-2:

Table 6-2. USACE National Inventory of Dams for Cape May County

| USACE Dam Inventory for Cape May County | | | |
|---|---|---|---|
| East Creek Pond Dam: July 7, 2022 | Johnson Pond Dam: July 13, 2023 | Nummytown Mill Pond Dam: July 13, 2023 | Magnolia Lake Dam: July 13, 2023 |
| Tarklin Pond Dam: 4/22/2022 April 22, 2022 | Ludlam Pond Dam: July 13, 2023 | Meisle (Nummy) Lake Dam: December 15, 2000 | West Creek Dam: May 17, 2022 |

*Source: National Inventory of Dams 2025*

Figure 6-2. Dams Located in Cape May County



## 6.1.3 Extent

Dam failures can occur suddenly, without warning, and under normal operating conditions—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.

According to the NJDEP Bureau of Dam Safety, the hazard classification of a dam is assigned according to the potential impacts of a dam failure. Dams are classified in terms of potential for downstream damage if the dam were to fail. These hazard classifications are identified and defined below (N. J. NJDEP 2017):

- *Low Hazard (Class III)* is a dam located in an area where failure will damage nothing more than isolated buildings, undeveloped lands, or township or county roads; and/or will cause no significant economic loss or serious environmental damage. Failure or mis operation would result in no probable loss of human life. Losses are principally limited to the owner's property.
- *Intermediate Hazard (Class II)* is a dam located in an area where failure may damage isolated homes, main highways, and minor railroads; interrupt the use of relatively important public utilities; and/or cause significant economic loss or serious environmental damage. Failure or mis operation would result in no probable loss of human life but may cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Dams classified as intermediate hazard dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- *High Hazard (Class I)* is a dam located in an area where failure may cause loss of human life, serious damage to homes, industrial or commercial buildings, important public utilities, main highways or railroads, and/or will cause extensive economic loss. This is a downstream hazard classification for dams in which excessive economic loss (urban area including extensive community, industry, agriculture, or outstanding natural resources) would occur as a direct result of dam failure.
- *Negligible or No Hazard (Class IV)* is a dam which is less than 15 feet in height, impound less than 15 acre feet of water to the top of dam, and drain less than 150 acres. No dam may be included in the Class IV category if failure of the dam could cause downstream property damage or loss of life.

## 6.1.4 Previous Occurrences

### FEMA Major Disaster and Emergency Declarations

Between 1954 and 2025, Cape May County was not included in any major disaster (DR) or emergency (EM) declarations for dam failure-related events (FEMA 2025).

### 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 August 2019 and March 2025, Cape May County was not included in any USDA dam failure-related agricultural disaster declarations.

### Previous Events

There has not been any reported dam failure events in Cape May County from August 2019 to March 2025. However, some dams located within the County have been noted to be in poor condition and could lead to a dam failure event. For events prior to 2019, refer to the 2019 Cape May County HMP.

## 6.1.5 Probability of Future Occurrences

The likelihood of a dam failure in Cape May County is difficult to predict. Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides, and excessive rainfall and snowmelt. However, the risk of such an event increases for each dam as the dam's age increases or the frequency of maintenance decreases.

"Residual risk" to dams is the risk that remains after the implementation of safeguards. Residual risk to dams 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.

Information on previous dam failure occurrences in the County was used to calculate the probability of future occurrence of such events, as summarized in Table 6-1. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. In Chapter 20, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for dam failure in the County is considered "*rare*".

Table 6-3. Probability of Future Dam Failure Events in Cape May County

| Hazard Type | Number of Occurrences Between 1954 and 2025 | Percent Chance of Occurring in Any Given Year |
|---|---|---|
| Dam Failure | 0 | 0.00% |

*Sources: ASDSO 2025*

### Climate Change Projections

Climate change is increasingly impacting both people and resources in New Jersey, with these effects projected to intensify over time. The state is already experiencing noticeable impacts related to rising temperatures and sea-level rise. These changes are evident in various sectors, including agriculture, infrastructure, and public health. To address these challenges, the New Jersey Department of Environmental Protection (NJDEP) and other state agencies are actively working on strategies to mitigate and adapt to the effects of climate change (N. J. NJDEP 2024).

One significant initiative is the New Jersey Climate Change Resilience Strategy Report (2021), which aims to provide decision-makers with comprehensive information on the state's vulnerability to climate change. This assessment facilitates the development of adaptation strategies that are informed by both local experiences and scientific knowledge. By understanding the specific risks and vulnerabilities, New Jersey can better prepare for and respond to the impacts of climate change (NJDEP 2021).

Dams in New Jersey are designed based on assumptions about a river's flow behavior, which are expressed through hydrographs. These hydrographs represent the flow rate of water over time and are crucial for determining the design and safety margins of dams. However, changes in weather patterns due to climate change can significantly alter the hydrographs used in dam design. For instance, increased precipitation and more frequent extreme weather events can lead to higher and more variable river flows (N. J. NJDEP 2024).

If the hydrograph changes, it is conceivable that a dam could lose some or all of its designed margin of safety, also known as freeboard. Freeboard is the vertical distance between the maximum water surface elevation and the top of the dam. Loss of this safety margin may result in floodwaters overtopping the dam or creating unintended loads on the structure. Such situations could compromise the integrity of the dam and potentially lead to dam failure, posing significant risks to downstream communities.

To address these concerns, the NJDEP's Bureau of Dam Safety continuously monitors and evaluates the condition of dams across the state. They also update design standards and safety protocols to account for changing climate conditions (N. J. NJDEP 2024). By proactively managing these risks, New Jersey aims to enhance the resilience of its infrastructure and protect its residents from the adverse effects of climate change.

### 6.1.6 Cascading Impacts on Other Hazards

Cascading impacts of flooding and dam failure inundation may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly, and pregnant women. The degree of impact will vary and is not strictly measurable. Mold spores can grow in as short a period as 24-48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to prevent mold growth (CDC n.d.).

Molds and mildews are not the only public health risk associated with flooding. Floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

## 6.2 VULNERABILITY AND IMPACT ASSESSMENT

### 6.2.1 Life, Health, and Safety

#### Overall Population

Warning time for dam failure is often limited. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, limiting their predictability and compounding the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard. Direct and indirect losses associated with dam failures include injury and loss of life, damage to structures and infrastructure, agricultural losses, utility failure (power outages), and stress on community resources.

Additionally, the impact of dam failure on life, health, and safety is dependent on several factors such as the area that the dam is protecting, the location, capacity, structural integrity, and the proximity of structures, infrastructure, and critical facilities downstream of the failure inundation area. According to the U.S. Army Corps of Engineers, the level of impact that a dam failure would have can be predicted based on the hazard potential classification. Table 7.2-1 outlines the recommended hazard classifications.

Table 7.2-1. United States Army Corps of Engineers Hazard Potential Classification for Dams

| Urgency of Action | Actions for Dams in This Class | Characteristics of This Class |
|---|---|---|
| Very High (1) | Take immediate action to avoid failure. Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions. Ensure the emergency action plan is current and functionally tested for initiating events. Conduct heightened monitoring and evaluation. Expedite investigations to support remediation using all resources and funding necessary. Initiate intensive management and situation reports. | Critically near failure: The Dam is almost certain to fail under normal operations to within a few years without intervention.<br><br>OR<br><br>Extremely high incremental risk: Combination of life or economic consequences with the likelihood of failure is very high. USACE considered this level of life risk to be unacceptable except in extraordinary circumstances. |
| High (2) | Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions as warranted. Ensure the emergency action plan is current and functionally tested for initiating events. Conduct heightened monitoring and evaluation. Expedite confirmation of classification. Give very high priority to investigations to support the need for remediation. | Failure initiation foreseen: For confirmed and unconfirmed dam safety issues, failure could begin during normal operations or be initiated as a consequence of an event. The likelihood of failure from one of these occurrences, before remediation, is too high to assure public safety.<br><br>OR<br><br>Very high incremental risk: the combination of life or economic consequences with the likelihood of failure is high. USACE considered this level of life risk to be unacceptable except in extraordinary circumstances. |
| Moderate (3) | Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions as warranted. Ensure the emergency action plan is current and functionally tested for initiating events. Conduct heightened monitoring and evaluation. Prioritize investigations to support the need for remediation informed by consequences and other factors. | Moderate to high incremental risk: For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with the likelihood of failure is moderate. USACE considers this level of life risk to be unacceptable except in unusual circumstances. |
| Low (4) | Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Conduct elevated monitoring and evaluation. Give normal priority to investigations to validate classification, but do not plan for risk reduction measures at this time. | Low incremental risk: For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with the likelihood of failure is low to very low and the dam may not meet all essential USACE guidelines. USACE considers this level of life risk to be in the range of tolerability but the dam does not meet all essential USACE guidelines. |
| Normal (5) | Continue routine dam safety activities and normal operations, maintenance, monitoring, and evaluation. | Very low incremental risk: The combination of life, economic, or environmental consequences with the likelihood of failure is low to very low and the dam meets all essential USACE guidelines. USACE considers this level of life-safety risk to be tolerable. |

*Source: USACE 2020*

As mentioned in the earlier sections, dam failure can cause in the most extreme case, loss of life and extensive property damage, or in the least extreme case, no loss of life or significant property damage. 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 the potential outcomes of flooding for each dam in Orleans County would require intensive hydraulic modeling.

### Socially Vulnerable Population

The entire population residing within a dam failure inundation zone is considered exposed and vulnerable. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact on their family. The population over the age of 65 is also highly vulnerable because they are more likely to seek or need medical attention that may not be available because of isolation during a flood event, and they may have more difficulty evacuating.

Older adults and young children may be more at risk due to limited mobility, communication, and dependency on others. Cascading impacts of dam failure, such as mold, may affect those who have compromised immune systems. Additionally, communities of color, certain immigrant groups, low-income groups, and those with limited English proficiency are more at risk because they may live in locations that are prone to the dam failure hazard. Additionally, they may have limited financial resources and experience cultural, language, and citizenship barriers that may restrict communication and access to emergency information (EPA 2023).

## 6.2.2 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 damages caused by dam failure will vary depending on the depth of flooding and velocity of the surge.

Dam failures 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.

## 6.2.3 Community Lifelines and Other Critical Facilities

Dam failures may also impact critical facilities and infrastructure located in the downstream inundation zone. Consequentially, dam failures can cut evacuation routes, limit emergency access, and/or create isolation issues. Emergency response would be hindered due to the loss of transportation routes as well as some protective-function facilities located in the inundation zone. Recovery time to restore many critical functions after an event may be lengthy, as wastewater, potable water, and other community facilities are located in the dam inundation zones. Dam failures can cause severe downstream flooding and may transport large volumes of sediment and debris, depending on the magnitude of the event. 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.

## 6.2.4 Economy

The impact of a dam failure on the economy and estimated dollar losses are difficult to measure. Dam failures can exert direct and indirect effects on society. Direct costs include actual damage sustained by buildings, property, and infrastructure. Direct building losses are estimated costs to repair or replace damaged buildings. Losses to Cape May County's building inventory would impact Cape May County's tax base and the local economy. Indirect costs, such as clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity, are difficult to measure. Estimated potential damage to general building stock can be quantified as discussed above. For this analysis, damage to general building stock is discussed below.

## 6.2.5 Natural, Historic and Cultural Resources

### Natural

The environment is vulnerable to several risks in the event of a dam or levee failure. Water releases from dams or levees usually contain very little suspended sediment; this can lead to scouring of riverbeds and banks. The inundation may introduce foreign elements into local waterways, resulting in destruction of downstream habitat and impacting many animal and plant species, especially endangered species. The subsequent rush of water downstream can rapidly increase flow rate and turbidity of streams and rivers in minor dam failures or overwhelm terrestrial habitat with floodwaters in severe dam failure events.

Dam and levee failures can often result in the release of hazardous materials, either swept up in floodwaters or in sediment that is contained behind the dam as is often the case in areas that have had mining activities that take place upstream. After the flood waters subside, contaminated and flood damaged building materials and contents must be properly disposed. Contaminated sediment must be removed from buildings, yards, and properties.

Dam and levee failures may result in significant water quality and debris disposal issues. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooding waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals get added to flood waters. Water supplies and wastewater treatment could be off-line for weeks. After the flood waters subside, contaminated and flood damaged building materials and contents must be disposed of properly.

### Historic

Dam and levee failures may impact historic resources by the resulting flood waters. Historic buildings and structures, sites, monuments, districts, and historic documents are often irreplaceable, and may become damaged or destroyed in the flood waters following a dam or levee failure. The loss of these resources is even more painful as residents rely on the presence of these resources to reinforce connections with neighbors and the larger community, and to seek comfort in the aftermath of a disaster.

### Cultural

Cape May County is home to numerous culturally significant assets, including museums and historical landmarks. A dam failure causing flooding, debris flow, and erosion could severely damage these structures, rendering them unsafe for public access. The loss of these cultural assets would negatively impact social cohesion and cultural diversity, as they serve as communal gathering places and symbols of shared history. Additionally, the destruction of these sites could have a detrimental economic impact, as they are significant sources of revenue through tourism.

# 6.3 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.

## 6.3.1 Potential or Planned Development

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.

## 6.3.2 Projected Changes in Population

An increase in population density 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. Refer to Chapter 3 (County Profile), which includes a more thorough discussion about population trends for the County.

## 6.3.3 Climate Change

Most studies indicate that the State of New Jersey will experience a rise in average annual precipitation, primarily in the form of heavy rainfalls, which could elevate the risk of dam failures. Increased precipitation may place additional stress on dam structures. Existing flood control systems might struggle to manage the higher water flow from more frequent, intense rainfall events. This could lead to more frequent overtopping of dams and flooding of county assets in adjacent inundation areas. However, the probable maximum flood used in dam design may still accommodate these climate changes.

Projections suggest that annual precipitation in the State of New Jersey could increase by 4 percent to 11 percent, potentially affecting the hydrographs of many dammed rivers. This rise in precipitation could reduce the designed margin of safety, known as freeboard, for dams. A decrease in freeboard may result in floodwaters overtopping the dam or creating unintended loads, potentially leading to dam failure (NJOEM 2024).

## 6.3.4 Other Identified Conditions

When assessing the risk of dam failure in the future, several conditions should be considered. Climate change, with its increased precipitation and extreme weather events, can place additional stress on dam structures, raising the likelihood of overtopping and structural failure. Seismic activity is another concern, as earthquakes can damage dams, particularly those not designed to withstand seismic forces.

Aging infrastructure is a significant risk factor, as many dams may not meet current safety standards and are more susceptible to failure due to wear and tear. Historical design and construction flaws can also become critical over time, especially under changing environmental conditions. Inadequate maintenance and delayed repairs further increase the risk of dam failure (FEMA 2018).

Issues with upstream dams can impact downstream dams, potentially leading to cascading failures. Development in areas surrounding dams, known as hazard creep, can heighten the potential consequences of a dam failure. Additionally, cybersecurity attacks and other security threats can alter dam operations and pose significant risks (CRS Report 2023).