5.1 Dam Failure

2023 SHMP Update Changes

- The hazard profile was reorganized and significantly enhanced to include detailed descriptions of the following: hazard definition, location, extent, previous occurrences, and probability of future occurrences (including how future conditions may impact the hazard).
- Dam failure events that occurred in the State of West Virginia (the State) from January 1, 2017, through December 31, 2022, were researched for this 2023 State Hazard Mitigation Plan (SHMP) Update.
- New and updated figures from federal, state, and local agencies are incorporated.
- State asset exposure to statewide dam inundation areas was analyzed. Local vulnerability was assessed using dam inundation areas of state-regulated dams.

5.1.1 Hazard Profile

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) (Association of State Dam Safety Officials 2022).

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 (Association of State Dam Safety Officials 2021):

- 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; and
- Seepage through a dam that is not properly filtered so that soil particles form sink holes in the dam (Association of State Dam Safety Officials 2021).

Location

The U.S. Army Corps of Engineers National Inventory of Dams (NID) identifies 561 dams in West Virginia (449 state-regulated and 112 non-state-regulated) (U.S. Army Corps of Engineers 2023). The West Virginia Dam Control and Safety Act (West Virginia State Code §22-14) defines state-regulated dams as:

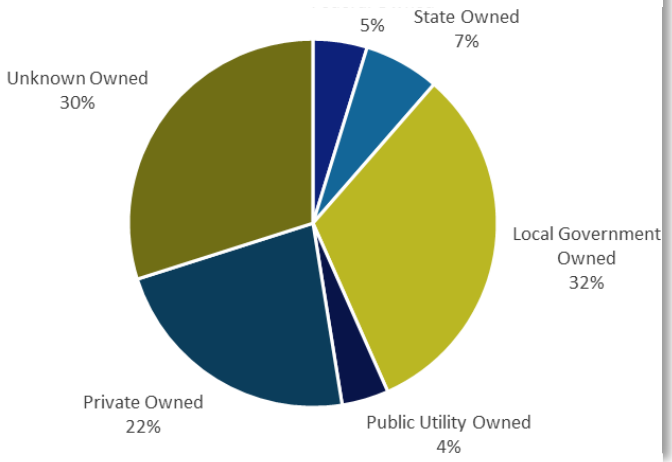
- 25 feet or more in height and impound 15 or more acre-feet (4,917,420 gallons) of water volume; or
- 6 feet or more in height and impound 50 or more acre-feet (16,391,400 gallons) of water volume (West Virginia Department of Environmental Protection 2023).

Exemptions from state-regulated dams include the following:

- Dams owned by the federal government;
- Dams that do not normally impound water, such as road fills with culverts sized to West Virginia Division of Highway (WVDOH) standards; or
- Dams built primarily for agricultural purposes and demonstrated to not cause loss of life if the dam fails (West Virginia Department of Environmental Protection 2023).

According to the West Virginia University GIS Technical Center (WVU GISTC), there are 632 dams located in West Virginia, with approximately 60 percent of the dams regulated by the state. The state-regulated dams fall under the jurisdiction of West Virginia Department of Environmental Protection (WVDEP) Division of Dam Safety. Dams and reservoirs owned by the federal government are not subject to state jurisdiction except as otherwise provided by federal law. According to the U.S. Army Corps of Engineers, there are 30 dams in West Virginia owned by federal government agencies, such as the U.S. Army Corps of Engineers and the U.S. Forest Service, as shown in Figure 5.1-1 (U.S. Army Corps of Engineers 2023).

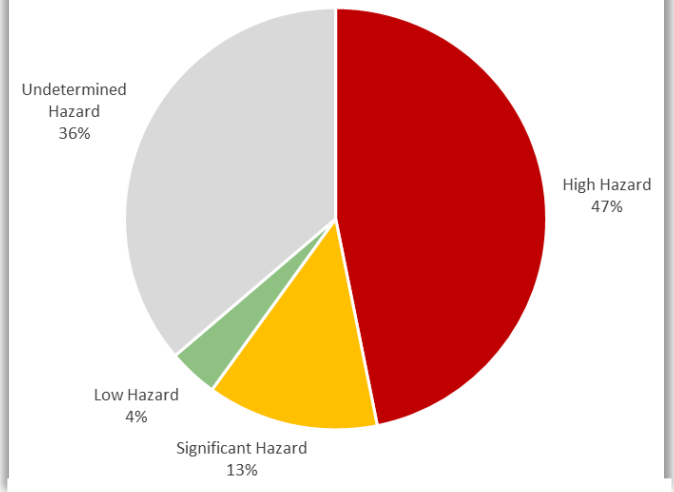
Figure 5.1-1. Dam Ownership in West Virginia



Source: WVU GISTC 2019

As shown in Figure 5.1-2, of the 632 dams, 153 have been identified as having high hazard downstream potential. Due to the number of such dams in West Virginia, information specific to each dam is not provided in this SHMP. Information can be accessed on the U.S. Army Corps of Engineers website (https://nid.sec.usace.army.mil/#/) and the WVDEP website https://dep.wv.gov/WWE/ee/ds/Pages/default.aspx).

Figure 5.1-2. Hazard Classification of Dams in West Virginia

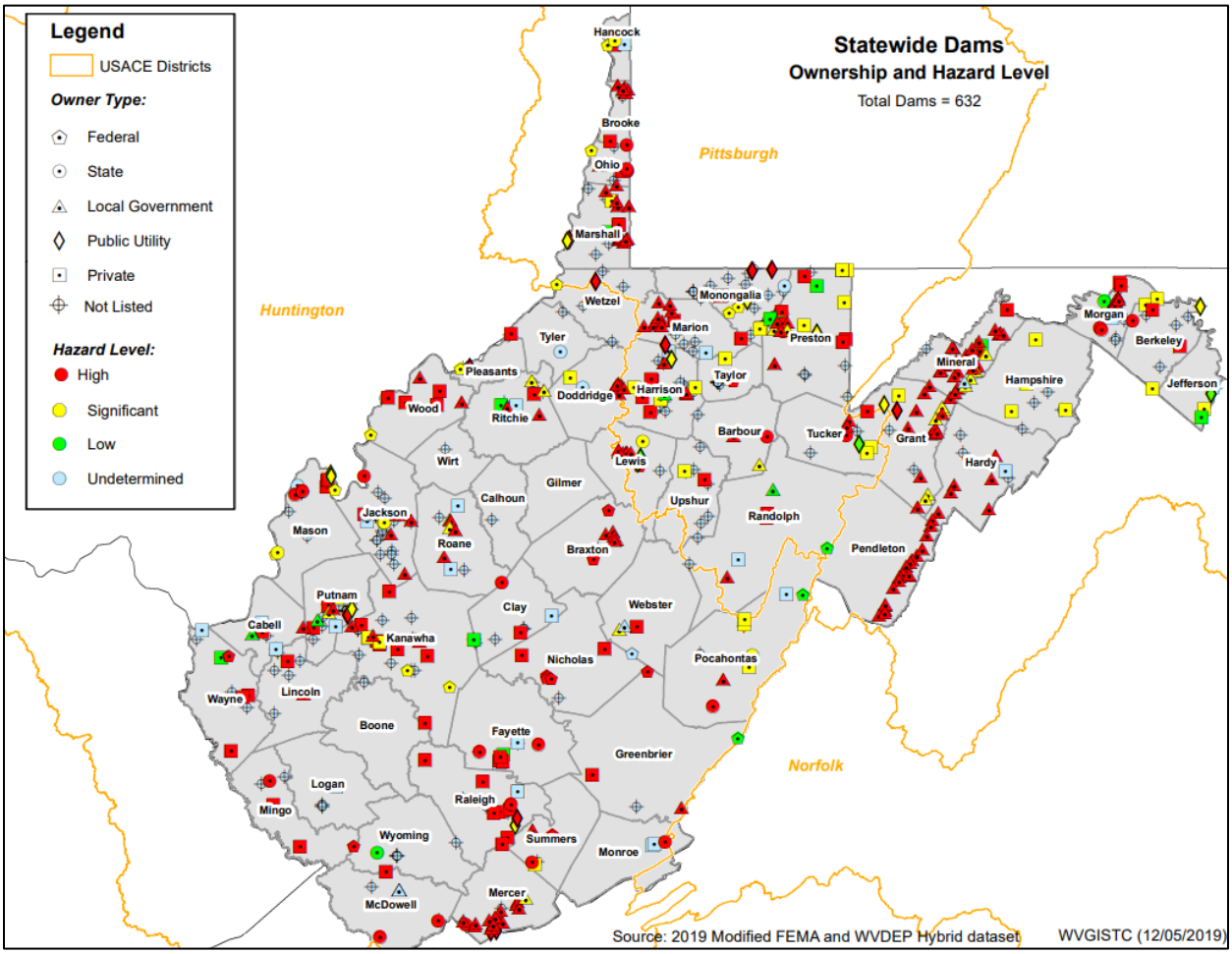


Source: WVU GISTC 2019

In the event of a failure or uncontrolled release of water, anything located within the inundation areas (downstream of the dam) would be flooded and impacts could be detrimental (Federal Emergency Management Agency 2013). Approximately 4.1 percent of the state's total square miles of land area is located within dam failure inundation areas. Mason County (48.2 percent), Putnam County (32.9 percent), and Cabell County (32.3 percent) have the greatest percentage of land in dam failure inundation areas (U.S. Army Corps of Engineers 2023) (WVU GISTC 2019).

Figure 5.1-3 illustrates the distribution of all dams (state- and non-state-regulated) throughout the state. Harrison County (33 dams), Mineral County (33 dams), and Preston County (31 dams) have the largest number of dams in West Virginia. Regarding hazard classifications, Mineral County has the highest number of high hazard dams (27 dams), followed by Mercer and Pendleton Counties with 19 high hazard dams each.

Figure 5.1-3. Dams Located in West Virginia



Source: WVU GISTC 2019

Table 5.1-1. Dams in West Virginia, by County

County	Total Number of Dams in County	Number of High Hazard Dams	Number of Significant Hazard Dams	Number of Low Hazard Dams	Number of Undetermined Hazard Dams
Barbour	4	2	1	0	1
Berkeley	11	3	3	0	5
Boone	2	1	0	0	1
Braxton	8	7	0	0	1
Brooke	9	8	0	0	1
Cabell	8	3	0	1	4
Calhoun	1	0	0	0	1

County	Total Number of Dams in County	Number of High Hazard Dams	Number of Significant Hazard Dams	Number of Low Hazard Dams	Number of Undetermined Hazard Dams
Clay	6	1	0	0	5
Doddridge	2	0	1	0	1
Fayette	11	6	0	1	4
Gilmer	0	0	0	0	0
Grant	24	15	7	0	2
Greenbrier	5	3	0	1	1
Hampshire	8	0	4	0	4
Hancock	5	1	2	0	2
Hardy	12	8	0	0	4
Harrison	33	17	4	1	11
Jackson	28	8	2	0	18
Jefferson	6	0	1	2	3
Kanawha	28	12	5	1	10
Lewis	16	9	1	2	4
Lincoln	7	2	0	0	5
Logan	4	0	0	0	4
Marion	16	10	1	0	5
Marshall	21	14	2	1	4
Mason	19	6	6	0	7
McDowell	10	3	0	0	7
Mercer	22	19	1	0	2
Mineral	33	27	4	1	1
Mingo	5	3	0	0	2
Monongalia	28	4	6	1	17
Monroe	3	1	0	0	2
Morgan	24	12	3	1	8
Nicholas	6	5	0	0	1
Ohio	10	6	1	0	3
Pendleton	19	19	0	0	0
Pleasants	3	1	1	0	1
Pocahontas	10	2	4	1	3
Preston	31	11	7	2	11
Putnam	22	4	4	1	13
Raleigh	15	10	2	0	3
Randolph	8	3	0	2	3
Ritchie	12	3	2	1	6
Roane	10	4	1	1	4
Summers	5	3	1	0	1
Taylor	8	1	0	0	7
Tucker	8	3	2	1	2
Tyler	4	1	0	0	3
Upshur	8	1	1	0	6
Wayne	10	5	0	1	4
Webster	4	1	1	0	2
Wetzel	6	1	1	0	4
Wirt	1	0	0	0	1
Wood	7	6	1	0	0
Wyoming	6	1	0	1	4
Total (Statewide)	**632**	**296**	**83**	**24**	**229**

Source: WVU GISTC 2019

EXTENT

The West Virginia Division of Safety of Dams assigns hazard ratings to large dams in the state based on a classification system developed by the Federal Emergency Management Agency (FEMA) (WVDEP 2023). FEMA categorizes the downstream hazard potential into three categories in increasing severity: Low, Significant, and High (FEMA 2013).

WVDEP, in accordance with West Virginia State Code §47-34 (Dam Safety Rule), evaluates dams based on hazard potential downstream. Hazard potential is not related to the structural integrity of a dam but strictly to the potential for downstream flooding (West Virginia Department of Environmental Protection 2023). Table 5.1-2 provides the hazard potential definitions for each of the four hazard classes of dams in West Virginia and provides the number of dams associated with each classification.

Table 5.1-2. Downstream Hazard Potential Classification of Dams in West Virginia

Downstream Hazard Potential Classification	Dam Safety Regulations Definition	Number of Dams in West Virginia
Class 1 (High Hazard)	Dams located where failure may cause loss of human life or major damage to dwellings, commercial or industrial buildings, main railroads, important public utilities, or where a high-risk highway may be affected or damaged. This classification must be used if failure may result in the loss of human life.	296
Class 2 (Significant Hazard)	Dams located where failure may cause minor damage to dwellings, commercial or industrial buildings, important public utilities, main railroads, or cause major damage to unoccupied buildings, or where a low-risk highway may be affected or damaged. The potential for loss of human life resulting from failure of a Class 2 dam must be unlikely.	83
Class 3 (Low Hazard)	Dams located in rural or agricultural areas where failure may cause minor damage to nonresidential and normally unoccupied buildings, or rural or agricultural land. Failure of a Class 3 dam would cause only a loss of the dam itself and a loss of property use, such as use of related roads, with little additional damage to adjacent property. The potential for loss of human life resulting from failure of a Class 3 dam must be unlikely. An impoundment exceeding forty (40) feet in height or four hundred (400) acre-feet storage volume shall not be classified as a Class 3 dam. A waste disposal dam, the failure of which may cause significant harm to the environment, shall not be classified as a Class 3 dam.	24
Class 4 (Negligible Hazard)	Dams where failure is expected to have no potential for loss of human life, no potential for property damage and no potential for significant harm to the environment. Examples of Class 4 dams include: dams across rivers, failure of which under any conditions will not flood areas above normal streambank elevations; dams located in the reservoir of another dam which, under any conditions, can contain water released by failure of the Class 4 dam; and dams in series where the toe of the Class 4 dam(s) is in close proximity to the reservoir of a dam which can contain failure of the Class 4 dam(s) under any condition. In considering a request for a Class 4 designation, the director may require written concurrence from the owner(s) of downstream dams that may be affected by failure of the Class 4 dam. Approval for use of this classification is vested in the director, and will be based on engineering evaluation of the dam(s) and downstream areas in question.	229

Sources: U.S. Army Corps of Engineers 2023; West Virginia Department of Environmental Protection 2023

Warning Time

High and significant hazard dam owners are required to prepare and maintain Monitoring & Emergency Action Plans (MEAP). The MEAP is to be used in the event of a potential dam failure or uncontrolled release of stored water. The monitoring portion of the plan sets forth a frequency of owner inspections that varies according to

weather conditions. As heavy rainfall occurs, the frequency of inspections increases. If an imminent danger is identified, the emergency action portion of the plan is designed to notify the downstream communities to evacuate to the designated safe areas (WVDEP 2023).

Previous Occurrences and Losses

Federal Emergency Management Agency (FEMA) Disaster Declarations

Between 1954 and 2022, West Virginia was included in five major disaster (DR) or emergency (EM) declarations for dam failure-related events (FEMA 2023). These events were classified as flooding, heavy winds, slides, landslides, and mudslides. While dam failure was identified in the declaration title or incident type, these events led to dam failures or incidents in West Virginia and are reflected in the table below.

Table 5.1-3. Dam Failure-Related Federal Declarations, 1954 to 2022

Incident Date(s)	Declaration	Incident Type	Declaration Title	Counties Declared
January 19-February 2, 1996	FEMA-DR-1096	Flood	Flooding	Berkeley, Brooke, Grant, Greenbrier, Hampshire, Hancock, Hardy, Jefferson, Marshall, Mason, Mercer, Mineral, Monroe, Morgan, Nicholas, Ohio, Pendleton, Pleasants, Pocahontas, Preston, Raleigh, Randolph, Summers, Tucker, Tyler, Webster, Wetzel, Wood
May 15-June 10, 1996	FEMA-DR-1115	Flood	Flooding, Heavy Winds	Barbour, Boone, Harrison, Lincoln, Logan, McDowell, Mercer, Mingo, Pendleton, Pocahontas, Raleigh, Randolph, Tucker, Upshur, Wayne, Wetzel, Wyoming
February 28-March 15, 1997	FEMA-DR-1168	Flood	Heavy & Wind Driven Rain, High Winds, Flooding, Slides	Braxton, Cabell, Calhoun, Clay, Gilmer, Jackson, Kanawha, Lincoln, Mason, Putnam, Roane, Tyler, Wayne, Wetzel, Wirt, Wood
April 14-18, 2007	FEMA-DR-1696	Severe Storm	Severe Storms, Flooding, Landslides, and Mudslides	Barbour, Boone, Cabell, Gilmer, Grant, Hardy, Lewis, Lincoln, Logan, McDowell, Mingo, Pendleton, Pocahontas, Putnam, Upshur, Wayne, Webster, Wyoming
May 3-June 8, 2009	FEMA-DR-1838	Severe Storm	Severe Storms, Flooding, Mudslides, and Landslides	Calhoun, Gilmer, Lewis, McDowell, Mercer, Mingo, Raleigh, Roane, Upshur, Wirt, Wyoming

Sources: Federal Emergency Management Agency 2023
FEMA Federal Emergency Management Agency
N/A Not Applicable
USDA U.S. Department of Agriculture

U.S. Department of Agriculture (USDA) Disaster Declarations

The Secretary of Agriculture from the 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 2012 and 2022, West Virginia was not included in any dam failure-related agricultural disaster declarations (USDA 2023).

Previous Events

In the past 100 years, there have been several dam failures or incidents in West Virginia. Table 5.1-4 lists dam failure events that impacted the State since 1890. This table includes events identified in the 2018 SHMP and events that occurred between January 1, 2018 through December 31, 2022.

Table 5.1-4. Dam Failure Events in the State of West Virginia (1890 to 2022)

Date(s) of Event	Event Type	Federal Disaster Declaration (if applicable)	Counties Affected	Description
March 31, 1890	Dam Incident at Little Kanawha River Dam	N/A	Putnam County	Details of this incident were not found during the 2023 SHMP update.
January 1, 1914	Dam Incident at Stony River Dam	N/A	Grant County	There was an uncontrolled release of the reservoir at this dam; no additional details were found regarding this incident.
1914 (exact date unknown)	Dam Failure	N/A	Lincoln County	Catastrophic failure of a coal mine tailings dam.
January 15, 1914	Dam Failure of Old Stony River Dam	N/A	Grant County	A reinforced concrete dam failed during a winter storm.
August 9, 1916	Dam Failure of Unnamed Dams	N/A	Kanawha and Boone Counties	Three dam failures were reported on August 9, 1916, as a result of inflow flooding. This included one in Boone County and two in Kanawha County. Overall, there were between 60 and 75 deaths related to the flooding impacts. • Boone County – An inflow flood caused a dam failure in Jarrolds Valley. • Kanawha County - An inflow flood caused an unnamed dam in the Cabin Creek Valley to break, resulting in extensive damage in this part of the state. Over $600,000 in damages. Rail lines, telephones, and coal companies were the hardest impacted. Another failure was reported between Acme and Kayford.
February 26, 1972	Dam Failure and Flooding – Buffalo Creek Dam	N/A	Logan County	Buffalo Creek flooding disaster was due to a catastrophic dam break. This coal slurry dam consisted of three embankments. One embankment failed as a result of heavy rain soaking the earthen dam, causing the subsequent failure of the other two. The result was a flood wave barreling through Logan County that killed 139 people and destroyed millions of dollars worth of property. Since the Buffalo Creek Dam failure and resulting flood, West Virginia has not experienced deaths due to a dam failure.
January 1, 1973	Dam Incident at Gath Right Dam	N/A	Morgan County	Overtopping resulted in breaching at the left abutment. This is the first of three similar incidents.
May 1, 1974	Dam Incident at Gath Right Dam	N/A	Morgan County	Overtopping resulted in breaching at the left abutment. Did not completely breach during this incident (third of three), though considerable downstream slope damage was sustained.
January 1, 1975	Dam Incident at R.D. Bailey Permanent Cofferdam	N/A	Mingo County	Overtopping and lateral and downward erosion were reported at this location; however, no additional details regarding this incident were found.
May 30, 1975	Dam Incident at Millville Dam	N/A	Hampshire County	Dam cap failed; no additional details regarding this incident were found.
September 30, 1988	Dam Incident at Millville Dam	N/A	Hampshire County	A cavity was found in Block 13 of the dam foundation, near east abutment. Cavity extended from upstream to downstream, with dimensions of 23 feet wide by 13 feet high.

Date(s) of Event	Event Type	Federal Disaster Declaration (if applicable)	Counties Affected	Description
January 1, 1991	Dam Incident at Unnamed Dam (WVS00005)	N/A	Unknown	Hurricane Andrew caused the brief overtopping of this small, unnamed dam located in the eastern panhandle. No major damage resulted.
January 19, 1996	Dam Incidents at Bruceton Mills Dam, Coolfont Dam, Terra Alta Lake Dam, and Thomas Dam	FEMA-DR-1096 (Flooding)	Preston, Morgan, and Tucker Counties	• Bruceton Mills Dam - The dam was completely overtopped during the snowmelt. The masonry blocks at the left abutment were washed away, causing instability in that area. The West Virginia Division of Water and Waste Management Dam Safety Section sent the owner a legal order requiring emergency repairs. • Coolfont Dam – Adverse conditions were reported at 11:12 A.M. Both the principal and emergency open channel spillways were reported to be in operation. • Terra Alta Lake Dam - The dam was overtopped in the early morning causing severe erosion and the loss of the majority of the downstream face. The spillway bridge was also damaged. The downstream face was left as a vertical slope. The Preston County Office of Emergency Services (OES) notified residents in accordance with the emergency action plan (EAP). The WVDEP Division of Dam Safety sent the owners a legal order requiring emergency repairs. The bridge over the spillway was closed to traffic, pending repairs. • Thomas Dam - Standby alert conditions were reported. Downstream residents were notified of the situation by the Tucker County OES, but were not evacuated. Maximum overtopping of the parapet wall was 8.5 inches at 9:20 A.M. Riprap placed to prevent erosion at the right abutment after overtopping incident in February 1994 remained in good condition.
January 29, 1996	Dam Incident at Ranch Lake Estates Dam	FEMA-DR-1096 (Flooding)	Putnam County	There was erosion visible along both sides of the outlet structure wing walls. Seepage was visible around the outlet end of both of the pipes. The owners cleared the debris from the drainpipe. The riser was subsequently demolished to effectively prohibit the structure's ability to impound water. The current configuration classified the structure as a road-fill (non-jurisdictional within the scope of West Virginia Dam Control Act).
May 16, 1996	Dam Incidents at Coolfont Dam and Lake Floyd Dam	FEMA-DR-1115 (Flooding, Heavy Winds)	Morgan and Harrison Counties	• Coolfont Dam - Owners of the dam reported emergency spillway flow. Inspectors from Environmental Enforcement checked the condition of the dam and found no damage. • Lake Floyd Dam - Reservoir rose to within three inches of overtopping the embankment before subsiding during heavy rainfall. Standby alert declared by monitors. No damage was reported.
May 31, 1996	Dam Incident at Chief Logan State Park Dam	N/A	Logan County	Erosion along the embankment of dam occurred during the first filling of reservoir. Because of this incident, the reservoir remained drained until repairs were effective. No other damages were reported.

Date(s) of Event	Event Type	Federal Disaster Declaration (if applicable)	Counties Affected	Description
June 19, 1996	Dam Incident at Indian Rocks Park Dam	N/A	Nicholas County	The Indian Rocks Park Dam overtopped during heavy thunderstorms. The embankment suffered considerable erosion but did not fail. Downstream homes were evacuated as a precaution.
February 21, 1997	Incident at Lake Chaweva Dam	N/A	Kanawha County	According to an inspection report, the concrete chute spillway exhibited open construction joints, leaning side walls, evidence of undermining, and washout of foundation materials along the left spillway wall. The slumping of embankment materials existed in close proximity to the spillway channel. The drainpipe was rusted completely through at the outlet. The integrity of the drainpipe through the interior of the dam was suspect. A downstream valve maintained the interior pipe under constant reservoir pressure creating the potential for interior embankment saturation and erosion. These conditions represented a serious problem as defined in the Dam Safety Regulations (of West Virginia). After the lake drawdown began, a landslide developed within the reservoir area. Dam Safety officials agreed to a reduced rate of drawdown. An order was issued that required the dam owners to drain the reservoir, submit an EAP, and submit plans to repair the dam.
March 1, 1997	Dam Incident at Victor Ryan Embankment Pond	FEMA-DR-1168 (Heavy & Wind Driven Rain, High Winds, Flooding, Slides)	Unknown	State Dam Safety personnel inspected the dam at Victor Ryan Embankment Pond. The reservoir overtopped, leaving the structure in a weakened condition. Surface water was flowing down the hill at the left abutment and across the crest of the embankment, and over the downstream face of the embankment. A seepage zone was identified near the right abutment with a flow of approximately 5 to 10 gallons per minute.
March 3, 1997	Dam Incident at Lake Washington Dam	FEMA-DR-1168 (Heavy & Wind Driven Rain, High Winds, Flooding, Slides)	Putnam County	The wooden flashboards along the crest of the concrete ambursen dam collapsed/washed out. No damage to the concrete ambursen structure was observed. As a result, the flashboards and associated pipe supports were removed after the flood event. This resulted in lower reservoir levels of approximately three feet. No downstream damage was reported.
October 11, 2000	Dam Failure in Big Sandy River watershed's Tug Fork	N/A	Mingo County	A dam in Inez, Kentucky affected WV streams and caused $56 million in cleanup costs across both states.
July 19, 2002	Dam Failure	N/A	Logan County	A coal waste valley fill slid into a pond, causing it to discharge through the emergency spillway and overtop, destroying three houses.
August 8, 2003	Dam Incident at Millville Dam	N/A	Jefferson County	A cavity with irregular shape was found on Block 12 of the dam's foundation. The cavity entrance is in rock approximately 12 feet underneath the bottom of the dam, directly below the downstream face of the concrete apron. No damages or impacts were reported for this event.
April 15, 2007	Dam Failure - Lee's Fishing Lake Dam	FEMA-DR-1696 (Severe Storms, Flooding,	Lincoln County	A privately-owned pond, Lee's Fishing Lake, rose 22 inches after 2.5 inches of rainfall in 24 hours. Nearly 1,000 people were evacuated, but no damage to the dam or surrounding area was reported.

Date(s) of Event	Event Type	Federal Disaster Declaration (if applicable)	Counties Affected	Description
		Landslides, and Mudslides)		
January 1, 2008	Dam Failure – Falls Run Dam	N/A	Marion County	The Falls Run Dam was breached by the West Virginia Department of Environmental Protection after a pipe clogged. No injuries, deaths or damages were reported for this event.
May 4, 2009	Dam Incident at Lake Lynn Dam	DR-1838 (Severe Storms, Flooding, Mudslides, and Landslides)	Monongalia County	Staff at the Allegheny Energy Supply Company, LLC observed an increase in seepage from the hillside located approximately 85 yards downstream from the Lake Lynn Dam (right abutment). This was most likely due to the excessive rainfall experienced May 2 and 3. No damages or injuries were reported for this event.

Sources: Association of State Dam Safety Officials 2023, FEMA 2023; National Performance of Dams Program 2018, West Virginia Emergency Management Division 2018
DR Major Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency

PROBABILITY OF FUTURE HAZARD EVENTS

Overall Probability

Dam failures are infrequent and usually coincide with events that cause them, such as landslides, excessive rain, and flooding. Dam incidents, which are less severe than actual dam failures, occurred multiple times per year in 1996 and 1997. According to FEMA, the National Performance of Dams Program, and the 2018 SHMP, the State experienced 26 dam failures/incidents between 1890 and 2022, as summarized in Table 5.1-5. Overall, the state is expected to experience fewer than one event every five years, with the possibility of an increase in frequency due to future changing conditions and aging infrastructure.

Table 5.1-5. Probability of Future Landslide Events in West Virginia

Hazard Type	Number Of Occurrences Between 1890 And 2022	Percent Chance of Occurrence in Any Given Year
Dam Failure	26	19.5%

Sources: National Performance of Dams Program 2018, West Virginia Emergency Management Division 2018, Federal Emergency Management Agency 2023

Projected Future Conditions

Projected future conditions may impact storm patterns and increase the probability of more frequent, extreme precipitation events and flooding, leading to increased risk of dam failures and incidents (Leslie 2019). In West Virginia, heavy rainstorms are becoming more frequent. Since 1895, total annual precipitation has been highly variable with a slight increase. Winter and spring precipitation totals are projected to increase, as well as the number and intensity of extreme precipitation events, creating an increased flood risk (NOAA National Centers for Environmental Information 2022).

Between 2010 and 2019, flooding has been the largest driver for dam failures in the United States. With projections of increased flooding and precipitation events, dams located in West Virginia may be more at risk of overtopping and failures associated with flooding (Association of State Dam Safety Officials 2021). Extreme rainfall events can severely damage dams or cause them to fail. Many older dams are not designed to modern standards and may not be able to withstand extreme weather events. The spillway systems of these dams may not be able to safely store or pass the excessive rain. This increased dam failure risk from projected flooding and precipitation events can lead to loss of life and property; impacts to the economy, infrastructure, and community; loss of water resources; and loss of flood protection (Association of State Dam Safety Officials 2015). With these projections, more intense events, combined with the aging dam infrastructure, could result in more dam failure incidents (Leslie 2019).

5.1.2 Vulnerability Assessment

To assess the vulnerability of state assets to the dam failure hazard, GIS software was used to overlay dam failure inundation areas with state facilities.

STATE ASSETS

Table 5.1-6 and Table 5.1-7 summarize the number and replacement cost value of state facilities located within dam failure inundation hazard areas. Kanawha County has the most facilities (147) and the highest total replacement cost value ($799,334,417) of State facilities. The Department of Health and Human Resources has the most facilities (28), while the Department of Administration General Services Division has the highest replacement cost value ($244,270,397) in the hazard area.

Table 5.1-6. State Facilities Located Within Dam Failure Inundation Areas, by County

State Facilities Located Within Dam Failure Inundation Hazard Area		Replacement Cost Value for State Facilities Within the Dam Failure Inundation Hazard Area By County		
County	Number of Structures	Replacement Cost Value (Structure Only)	Replacement Cost Value (Contents Only)	Total Replacement Cost Value (Structure and Contents)
Barbour	0	$0	$0	$0
Berkeley	0	$0	$0	$0
Boone	0	$0	$0	$0
Braxton	6	$2,419,153	$398,600	$2,817,753
Brooke	2	$0	$60,000	$60,000
Cabell	10	$12,047,696	$1,499,100	$13,546,796
Calhoun	1	$0	$300,000	$300,000
Clay	2	$0	$243,100	$243,100
Doddridge	0	$0	$0	$0
Fayette	3	$34,004,142	$2,690,000	$36,694,142
Gilmer	1	$0	$0	$0
Grant	0	$0	$0	$0
Greenbrier	0	$0	$0	$0
Hampshire	0	$0	$0	$0
Hancock	0	$0	$0	$0
Hardy	0	$0	$0	$0
Harrison	0	$0	$0	$0
Jackson	0	$0	$0	$0
Jefferson	0	$0	$0	$0
Kanawha	147	$627,036,530	$172,297,887	$799,334,417
Lewis	0	$0	$0	$0
Lincoln	1	$25,000	$0	$25,000
Logan	15	$23,475,000	$4,301,100	$27,776,100
Marion	3	$0	$77,500	$77,500
Marshall	4	$7,088,934	$871,000	$7,959,934
Mason	7	$225,000	$406,050	$631,050
McDowell	0	$0	$0	$0
Mercer	0	$0	$0	$0
Mineral	5	$2,747,022	$783,000	$3,530,022
Mingo	0	$0	$0	$0
Monongalia	3	$2,092,192	$606,425	$2,698,617
Monroe	0	$0	$0	$0
Morgan	0	$0	$0	$0
Nicholas	0	$0	$0	$0
Ohio	4	$8,904,384	$2,062,000	$10,966,384
Pendleton	0	$0	$0	$0
Pleasants	0	$0	$0	$0
Pocahontas	0	$0	$0	$0
Preston	0	$0	$0	$0
Putnam	14	$48,723,773	$25,767,725	$74,491,498

State Facilities Located Within Dam Failure Inundation Hazard Area		Replacement Cost Value for State Facilities Within the Dam Failure Inundation Hazard Area By County		
County	Number of Structures	Replacement Cost Value (Structure Only)	Replacement Cost Value (Contents Only)	Total Replacement Cost Value (Structure and Contents)
Raleigh	0	$0	$0	$0
Randolph	0	$0	$0	$0
Ritchie	0	$0	$0	$0
Roane	0	$0	$0	$0
Summers	0	$0	$0	$0
Taylor	2	$0	$422,000	$422,000
Tucker	0	$0	$0	$0
Tyler	0	$0	$0	$0
Upshur	0	$0	$0	$0
Wayne	5	$727,769	$755,000	$1,482,769
Webster	0	$0	$0	$0
Wetzel	0	$0	$0	$0
Wirt	0	$0	$0	$0
Wood	0	$0	$0	$0
Wyoming	0	$0	$0	$0
Total	235	$769,516,595	$213,540,487	$983,057,082

Sources: U.S. Army Corps of Engineers 2023, WVU GISTC 2019

Table 5.1-7. State Facilities Located Within Dam Failure Inundation Areas, by Agency

State Facilities Located Within Dam Failure Inundation Hazard Area		Replacement Cost Value for State Facilities Within the Dam Failure Inundation Hazard Area By Agency		
Agency	Number of Structures	Replacement Cost Value (Structure Only)	Replacement Cost Value (Contents Only)	Total Replacement Cost Value (Structure + Contents)
Adjutant General's Office State of West Virginia	0	$0	$0	$0
Administration, Secretary of Department of Administration	1	$0	$112,000	$112,000
Agriculture, Department of State of West Virginia	0	$0	$0	$0
Air And Environmental Quality Boards State of West Virginia	1	$0	$60,000	$60,000
Alcohol Beverage Control Administration State of West Virginia	1	$8,398,535	$5,375,000	$13,773,535
Architects, Board of State of West Virginia	1	$0	$17,000	$17,000
Armory Board State of West Virginia	10	$67,621,146	$20,394,500	$88,015,646
Arts, Culture & History, Department of State of West Virginia	2	$4,384	$2,000	$6,384
Attorney General, Office of The State of West Virginia	0	$0	$0	$0
Aviation, Division of	0	$0	$0	$0
Bar, State State of West Virginia	0	$0	$0	$0
Barbers & Cosmetologists, Board of State of West Virginia	1	$0	$100,000	$100,000
Blue Ridge Community & Technical College	0	$0	$0	$0
Bluefield State College	0	$0	$0	$0
Board of Treasury Investments	1	$0	$70,000	$70,000
Bridgevalley Community & Tech College	1	$29,146,767	$2,690,000	$31,836,767
Cedar Lakes Conference Center State of West Virginia	0	$0	$0	$0
Chiropractic Examiners Board State of West Virginia	1	$0	$100,000	$100,000
Commission For National And Community Service, WV	1	$0	$80,000	$80,000
Concord University	0	$0	$0	$0
Conservation Agency, West Virginia State of West Virginia	2	$0	$11,000	$11,000

State Facilities Located Within Dam Failure Inundation Hazard Area		Replacement Cost Value for State Facilities Within the Dam Failure Inundation Hazard Area By Agency		
Agency	Number of Structures	Replacement Cost Value (Structure Only)	Replacement Cost Value (Contents Only)	Total Replacement Cost Value (Structure + Contents)
Consolidated Public Retirement Board Department of Administration	1	$0	$1,500,000	$1,500,000
Consumer Advocate, Division of WV Public Service Commission	1	$0	$150,000	$150,000
Corrections, Division of State of West Virginia	4	$11,148,000	$1,253,000	$12,401,000
Courthouse Facilities Improvement Authority	1	$300,000	$200,000	$500,000
Dentistry, Board of State of West Virginia	0	$0	$0	$0
Department of Transportation	0	$0	$0	$0
Dietitians, Board of Licensed	0	$0	$0	$0
Eastern Panhandle Instructional Coop	1	$0	$50,000	$50,000
Eastern WV Community & Tech. College	0	$0	$0	$0
Economic Development Authority State of West Virginia	0	$0	$0	$0
Economic Development, WV Dept of	0	$0	$0	$0
Education, Department of State of West Virginia	5	$0	$570,000	$570,000
Educational Broadcasting Authority State of West Virginia	0	$0	$0	$0
Enterprise Resource Planning Board, WV	1	$0	$2,000,000	$2,000,000
Environmental Protection, Division of State of West Virginia	7	$11,500	$1,101,591	$1,113,091
Ethics Commission, West Virginia Department of Administration	1	$65,000	$65,000	$130,000
Examiners In Counseling, Board of State of West Virginia	1	$0	$6,000	$6,000
Fairmont State University	0	$0	$0	$0
Fire Commission State of West Virginia	1	$0	$500,000	$500,000
Fleet Management Office, Dept of Admin State of West Virginia	1	$0	$50,000	$50,000
Forestry, Division of State of West Virginia	0	$0	$0	$0
General Services Division Department of Administration	12	$223,442,223	$20,828,174	$244,270,397
Geological And Economic Survey State of West Virginia	0	$0	$0	$0
Glenville State College	0	$0	$0	$0
Governor, Office of The State of West Virginia	1	$0	$2,000,000	$2,000,000
Health & Human Resources, Department of State of West Virginia	28	$113,490,000	$48,680,000	$162,170,000
Higher Education Policy Commission, WV	2	$17,580,000	$1,542,246	$19,122,246
Highways, Division of State of West Virginia	23	$33,542,098	$8,503,236	$42,045,334
Homeland Security & Emergency Management Division	1	$0	$205,000	$205,000
Insurance Commissioner, Office of The State of West Virginia	0	$0	$0	$0
Investment Management Board, WV State of West Virginia	1	$0	$2,500,000	$2,500,000
Joint Committee On Government & Finance State of West Virginia	0	$0	$0	$0
Justice & Community Services, Div. of	1	$0	$750,000	$750,000
Juvenile Services, Division of	5	$7,504,700	$1,399,800	$8,904,500
Labor, Division of State of West Virginia	1	$0	$975,000	$975,000
Land Division/Dept of Agriculture State of West Virginia	0	$0	$0	$0
Landscape Architects, Board of State of West Virginia	1	$0	$2,500	$2,500
Library Commission State of West Virginia	0	$0	$0	$0
Lottery Commission State of West Virginia	1	$46,200,000	$8,500,000	$54,700,000
Marshall University	0	$0	$0	$0

State Facilities Located Within Dam Failure Inundation Hazard Area		Replacement Cost Value for State Facilities Within the Dam Failure Inundation Hazard Area By Agency		
Agency	Number of Structures	Replacement Cost Value (Structure Only)	Replacement Cost Value (Contents Only)	Total Replacement Cost Value (Structure + Contents)
Military Affairs, Secretary of And Public Safety	1	$0	$350,000	$350,000
Miner's Health Safety, Division of And Training, State of West Virginia	0	$0	$0	$0
Motor Vehicles, Division of State of West Virginia	6	$1,000,000	$5,203,000	$6,203,000
Mountain State Esc	1	$1,000,000	$250,000	$1,250,000
Mountwest Community & Technical College	0	$0	$0	$0
National Coal Heritage Area Authority	0	$0	$0	$0
Natural Resources, Division of State of West Virginia	3	$50,000	$1,003,000	$1,053,000
New River Community & Technical College	0	$0	$0	$0
Northern Community & Tech College, WV College Square	1	$8,900,000	$2,000,000	$10,900,000
Occupational Therapy Board State of West Virginia	0	$0	$0	$0
Office of Technology/IS&C Department of Administration	5	$0	$22,382,000	$22,382,000
Osteopathic Medicine, WV Board of State of West Virginia	1	$0	$25,000	$25,000
Osteopathic Medicine, WV School of	3	$0	$26,900	$26,900
Parks, West Virginia State C\O Division of Natural Resources	4	$7,061,496	$744,100	$7,805,596
Pharmacy, Board of State of West Virginia	1	$850,000	$80,000	$930,000
Physical Therapy, Board of State of West Virginia	0	$0	$0	$0
Pierpont Community And Technical College	0	$0	$0	$0
Practical Nurses, Board of State of West Virginia	0	$0	$0	$0
Prosecuting Attorneys Institute, WV	1	$0	$121,000	$121,000
Psychologists Examiners, Board of State of West Virginia	1	$0	$45,000	$45,000
Public Service Commission State of West Virginia	2	$14,844,069	$3,365,000	$18,209,069
Purchasing, Division of Department of Administration	2	$155,000	$1,196,000	$1,351,000
Rail Authority State of West Virginia	0	$0	$0	$0
Real Estate Commission State of West Virginia	1	$0	$150,000	$150,000
Regional Jail & Corr. Fac. Authority State of West Virginia	0	$0	$0	$0
Registered Nurses, Board of State of West Virginia	1	$0	$250,000	$250,000
Rehabilitation Services Division of Commerce	6	$0	$6,295,249	$6,295,249
Respiratory Care, WV Board of	0	$0	$0	$0
School Building Authority, West Virginia	1	$500,000	$300,000	$800,000
Schools For The Deaf And The Blind State of West Virginia	0	$0	$0	$0
Senior Services, Bureau of State of West Virginia	0	$0	$0	$0
Shepherd University	0	$0	$0	$0
Southern Educational Services Coop	0	$0	$0	$0
Southern WV Community & Tech College	0	$0	$0	$0
Speech Pathology & Audiology Examiners West Virginia Board of	0	$0	$0	$0
State Police, West Virginia Dept of Military Affairs & Public Safety	16	$25,761,623	$11,763,600	$37,525,223
Supreme Court of Appeals State of West Virginia	14	$0	$2,640,800	$2,640,800
Tax Appeals, WV Office of	1	$0	$130,000	$130,000
Tax Department State of West Virginia	3	$0	$5,110,000	$5,110,000
Treasurer of State State of West Virginia	2	$0	$1,165,000	$1,165,000
University Physicians And Surgeons	6	$530,000	$665,000	$1,195,000
Unknown	16	$0	$0	$0
Veterans Assistance, Department of State of West Virginia	0	$0	$0	$0
Veterinary Medicine, Board of State of West Virginia	0	$0	$0	$0
Water Development Authority State of West Virginia	1	$6,500,000	$1,000,000	$7,500,000

State Facilities Located Within Dam Failure Inundation Hazard Area		Replacement Cost Value for State Facilities Within the Dam Failure Inundation Hazard Area By Agency		
Agency	Number of Structures	Replacement Cost Value (Structure Only)	Replacement Cost Value (Contents Only)	Total Replacement Cost Value (Structure + Contents)
West Liberty University	0	$0	$0	$0
West Virginia Parkways Authority	3	$4,673,500	$3,485,000	$8,158,500
West Virginia State University - Institute	1	$130,503,950	$9,519,200	$140,023,150
West Virginia State University - Malden	1	$1,114,000	$115,000	$1,229,000
West Virginia University	0	$0	$0	$0
West Virginia University Arthurdale	0	$0	$0	$0
West Virginia University At Parkersburg	0	$0	$0	$0
West Virginia University Beckley	0	$0	$0	$0
West Virginia University Bruceton Mills	0	$0	$0	$0
West Virginia University Charleston	1	$14,207	$777,591	$791,798
West Virginia University Fort Ashby	1	$2,747,022	$705,000	$3,452,022
West Virginia University Granville	0	$0	$0	$0
West Virginia University Jacksons Mill	0	$0	$0	$0
West Virginia University Kearneysville	0	$0	$0	$0
West Virginia University Keyser	0	$0	$0	$0
West Virginia University Montgomery	1	$4,857,375	$0	$4,857,375
West Virginia University Reedsville	0	$0	$0	$0
West Virginia University Union	0	$0	$0	$0
West Virginia University Wardensville	0	$0	$0	$0
West Virginia University Weston	0	$0	$0	$0
Workforce West Virginia	1	$0	$50,000	$50,000
WV Public Employees Grievance Board	1	$0	$285,000	$285,000
WVsom Clinic Inc Dba Robert C Byrd Clinic	0	$0	$0	$0
Total (WV State)	235	$769,516,595	$213,540,487	$983,057,082

Sources: U.S. Army Corps of Engineers 2023, WVU GISTC 2019

Critical Facilities and Community Lifelines

Transportation routes, including bridges and highways, are vulnerable to inundation from dam failures and have the potential to be destroyed, creating isolation and supply chain issues. Those that are most vulnerable are those that are already in poor condition or older in age and would not be able to withstand large amounts of water. Table 5.1-8 summarizes the total number of critical facilities, by community lifeline, located in the dam inundation areas statewide.

Table 5.1-8. Critical Facilities and Community Lifelines Exposure to Dam Failure Inundation Areas

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area	% of Total Facilities
Communications	7	6	85.7%
Energy	0	0	0.0%
Food, Water, Shelter	8	2	25.0%
Hazardous Material	0	0	0.0%
Health & Medical	12	3	25.0%
Safety & Security	149	46	30.9%
Transportation	9	3	33.3%
Total	**185**	**60**	**32.4%**

Sources: U.S. Army Corps of Engineers 2023, WVU GISTC 2019

POPULATION

A minor dam failure may wash out into small streams or open fields, with little to impacts of populated areas. A major dam failure can greatly increase flooding and subsequent damages, buildings, infrastructure, and lifelines within inundation hazard areas. This could also lead to loss of life and injury, displacement, and increased distress of residents. Those that rely on water supply protected by dams, in the event the dam fails, they may lose access to drinking water (Federal Emergency Management Agency 2016). The risk analysis for dam failure found that 5.5 percent (100,100 people) of the state's total population lives within dam failure inundation hazard areas. Details regarding the population located in dam failure inundation hazard areas are shown in Table 5.1-9.

Impacts on Socially Vulnerable Populations

The risk analysis for dam failure found that 21.3 percent of people exposed to the dam failure inundation hazard areas are identified as socially vulnerable (21,344 people) (see Table 5.1-9). Studies have shown that socially vulnerable populations are more likely to be adversely affected by hazard events, like dam failures, and are less likely to recover such events (Flanagan, et al. 2011).

Table 5.1-9. Population Located Within the Dam Failure Inundation Hazard Area

County	Highly Vulnerable Population	Total Population	% Population Highly Vulnerable
Barbour	0	12	0.0%
Berkeley	0	2,470	0.0%
Boone	6	7	77.9%
Braxton	118	401	29.4%
Brooke	0	677	0.0%
Cabell	2,508	11,667	21.5%
Calhoun	0	141	0.0%
Clay	76	143	52.8%
Doddridge	0	0	0.0%
Fayette	116	1,910	6.1%
Gilmer	294	537	54.7%
Grant	0	0	0.0%
Greenbrier	0	4	0.0%
Hampshire	112	147	75.7%
Hancock	21	54	39.5%
Hardy	0	0	0.0%
Harrison	0	975	0.0%
Jackson	0	351	0.0%
Jefferson	0	306	0.0%
Kanawha	12,222	46,457	26.3%
Lewis	0	4	0.0%
Lincoln	0	821	0.0%
Logan	2,578	4,457	57.9%
Marion	156	2,167	7.2%
Marshall	711	1,735	41.0%
Mason	0	3,076	0.0%
McDowell	0	0	0.0%
Mercer	0	8	0.0%
Mineral	35	1,316	2.7%
Mingo	0	162	0.0%
Monongalia	73	2,216	3.3%
Monroe	0	24	0.0%

County	Highly Vulnerable Population	Total Population	% Population Highly Vulnerable
Morgan	0	216	0.0%
Nicholas	0	256	0.0%
Ohio	1,561	4,891	31.9%
Pendleton	0	0	0.0%
Pleasants	0	0	0.0%
Pocahontas	0	0	0.0%
Preston	0	0	0.0%
Putnam	0	4,805	0.0%
Raleigh	14	153	8.9%
Randolph	0	0	0.0%
Ritchie	0	0	0.0%
Roane	0	28	0.0%
Summers	50	1,145	4.4%
Taylor	694	1,399	49.6%
Tucker	0	0	0.0%
Tyler	0	0	0.0%
Upshur	0	0	0.0%
Wayne	0	4,281	0.0%
Webster	0	2	0.0%
Wetzel	0	0	0.0%
Wirt	0	126	0.0%
Wood	1	460	0.2%
Wyoming	0	91	0.0%
Total	21,344	100,098	21.3%

Sources: U.S. Army Corps of Engineers 2023, WVU GISTC 2019

Future Changes That May Impact State Vulnerability

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

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

Potential or Projected Development

Any sections of growth located within the dam inundation areas and near the dam inundation areas could potentially be impacted by a dam failure. While existing floodplain development regulations in place at the county level may offer some protection for new development located in these areas, such protections would likely not be sufficient in many instances in the event of a catastrophic dam failure. This results from a number of factors, such as the extent of the dam inundation areas may be larger than the regulated floodplain and water depths and velocities may be stronger and higher than the 1 percent annual chance flood event.

Projected Changes in Population

While statewide population has declined over the past 10 years, population has increased in several areas throughout the state (e.g., Berkeley, Jefferson, and Monongalia Counties). From 2010 to 2019, the state's overall population decreased by 3.3 percent, and it is projected to decrease 7.8 percent by 2040 (West Virginia

Department of Transportation 2020). As the overall population decreases, fewer people will be exposed to dam inundation hazard areas. However, counties with projected population increases, especially those with larger percentages living in dam inundation hazard areas, will have an increased risk of damages from dam failures.

Other Factors of Change

As discussed above, projected future conditions in West Virginia show an increased probability of more frequent, extreme precipitation and flooding events. Increased precipitation may stress dams, and the dams may not be able to retain and manage increases in water flow. With these projections, more intense events, combined with the aging dam infrastructure, could result in more dam failure incidents (Leslie 2019).

5.1.3 Consequence Analysis

Impacts to the Public

Impacts to the public are described in the Population section of Section 5.1.2, above.

Impacts to Responders

Dam failures can cause downstream flooding and can transport large volumes of sediment and debris, closing roadways and restricting access for residents and first responders. Other than the population in the dam failure inundation zone, the safety of the first responders on-scene is also at risk. First responders would be responsible for traffic control and responding to transportation accidents. They will also be responding to populations affected by flooding from the dam failure, risking their lives and safety while responding. All of these impacts can lead to burnout and secondary traumatic stress, even well after the response is over (Centers for Disease Control and Prevention 2018).

Impacts to Continuity of Operations

Dam failure events create flooding and downed trees, electrical wires, communication towers, and telephone poles and lines. Communication and power can be disrupted for days while utility companies work to repair the extensive damage. Continuity of operations, including continued delivery of services, may be impeded, and additional personnel would potentially be needed due to the lack of fire and police personnel in the state.

Impacts to Property, Facilities, and Infrastructure

Properties, facilities, and infrastructure located within dam inundation hazard areas can experience significant impacts and damages in the event of a dam failure. For State facilities and infrastructure impacts, refer to Table 5.1-6, Table 5.1-7, and Table 5.1-8. In addition, impacts to infrastructure (e.g., potable water intakes) from dam failure will mirror impacts due to flooding, as described in Section 5.5.

Table 5.1-10. State Roads Located Within Dam Failure Inundation Hazard Areas, by County

State Roads Located Within the Dam Failure Inundation Hazard Area			
County	Mileage of Roadway	**County**	**Mileage of Roadway**
Barbour	0.0	Mineral	10.7
Berkeley	0.1	Mingo	6.3
Boone	0.0	Monongalia	6.3
Braxton	34.1	Monroe	0.1
Brooke	1.2	Morgan	1.4
Cabell	14.4	Nicholas	15.2
Calhoun	4.3	Ohio	1.3
Clay	33.2	Pendleton	0.0
Doddridge	0.0	Pleasants	0.0
Fayette	15.5	Pocahontas	0.0
Gilmer	13.2	Preston	0.0
Grant	0.0	Putnam	49.5
Greenbrier	0.0	Raleigh	4.1
Hampshire	0.0	Randolph	0.0
Hancock	1.3	Ritchie	0.0
Hardy	0.0	Roane	0.0
Harrison	1.5	Summers	15.1
Jackson	1.4	Taylor	2.7
Jefferson	0.0	Tucker	0.0
Kanawha	75.7	Tyler	0.0
Lewis	0.0	Upshur	0.0
Lincoln	30.7	Wayne	36.4
Logan	62.1	Webster	0.1
Marion	1.2	Wetzel	0.0
Marshall	3.1	Wirt	0.8
Mason	52.3	Wood	0.9
McDowell	0.0	Wyoming	0.3
Mercer	0.0	**Total**	**496.5**

Sources: U.S. Army Corps of Engineers 2023, WVDOT 2021

Impacts to the Environment

Dam failures can cause downstream flooding and can transport large volumes of sediment and debris. Other examples of environmental impacts include pollution from septic system failures; pollution of potable water supplies; changes in configurations of streams; loss of wildlife habitats; and degradation of wetlands (Federal Emergency Management Agency 2012). The mining industry uses dams to contain mining waste (e.g., tailings containing crushed rock and processing fluids) and can cause significant impacts to the environment if they fail (Chambers 2023). A failure could release toxic materials into rivers and other bodies of water, affecting water and sediment quality and aquatic and human life (Kossoff 2014).

Impacts to the Economic Condition of the State

Depending on the severity of the dam failure event, damage to state assets can include structural damage from flooding, power outages, and debris. This can lead to road closures, limiting access to emergency personnel. Loss estimations for the dam failure hazard profiled in this assessment are based on complete damage of state facilities located within dam failure inundation hazard areas (refer to Table 5.1-6).

Another economic impact is mining. Impoundments and dams are an integral part of mining and are used to impound waste, store water for mine use, control runoff, and prevent flooding. Faulty design, construction, or operation can lead to a failure of the dam embankment or the containment system, resulting in the release of water or liquid-borne solid waste (Mine Safety and Health Administration 2023). A failure could significantly impact mining production, lead to fatalities and injuries, destroy homes and buildings, and cause environmental hazards depending on what is behind the dam. This was experienced in 1972 when three coal waste dams at the Buffalo Creek Mine failed, killing 125 people and injuring 1,100 more in communities downstream of the dams. Approximately 550 homes were destroyed, and more than 900 homes were damaged. Total property damage was estimated at $50 million (about $340 million in 2022 dollars) (Mine Safety and Health Administration 2022).

Impacts to Public Confidence in State Governance

One of the fundamental functions of government is to protect residents from threats to their health, safety, and welfare. Land use planning, public awareness, and emergency planning are all actions the government (state and local) can implement to help protect residents, buildings, critical facilities, and infrastructure. However, any type of dam failure can have negative impacts on how residents feel the government is responding to and protecting them from damages (TCEQ 2021).