4.4 Dam Failure

4.4.1 Hazard Profile

Dam failure is a collapse or breach in a dam. In recent years, aging infrastructure and population growth in floodplain areas downstream from dams and near levees have resulted in an increased emphasis on safety, operation, and maintenance of dams. While most dams have storage volumes small enough that failures have little or no repercussions, dams with large storage volumes can cause significant downstream flooding in the event of a breach.

Various types of dams exist to serve a multitude of functions within the CVPDC area. These include farm use, recreation, hydroelectric power generation, flood and storm-water control, water supply and fish or wildlife ponds. In some cases, a single dam structure serves multiple functions, such as generating hydroelectric power and providing recreational opportunities to boaters and fishermen.

4.4.1.1 Geographic Location/ Extent

The federal and most state governments regulate certain impounding structure (dam) planning, construction, operation, maintenance, and repair. On the state level, the Virginia Dam Safety Act of 1982 (and as amended effective December 22, 2010) serves as the guiding legislation. In Virginia, the Virginia Soil and Water Conservation Board has statutory authority to administer the Virginia Dam Safety Program. The Virginia Department of Conservation and Recreation (DCR), Division of Dam Safety and Floodplain Management, aids the Virginia Soil and Water Conservation Board in the administration of the Virginia Dam Safety Program. DCR oversees a dam safety and floodplain management program to ensure that dams are properly and safely designed, built, operated, and maintained. There are a total of 255 dams (impounding structures) located across the CVPDC area, managed by three of the assigned DCR dam safety regions (III, IV and V. Figure 4-51). 113 of those dams are listed as regulated, 20 are non-regulated, and 122 dams in the region are listed as “undetermined”. This is important, since dam owners bear the responsibility of their upkeep and they are responsible when dams fail and cause environmental, economic, and personal damage. DCR’s past program to locate and identify these dams was known as dam DRAGNET. Currently the initiative to determine the status of those impounding structures which have “Undetermined” regulatory status is called the Preliminary Regulatory Determination/Unknown Dam Initiative (PRD-UDI). Eight of the CVPDC area dams are found along Virginia’s longest river, James River, and six of these are currently producing hydroelectricity.

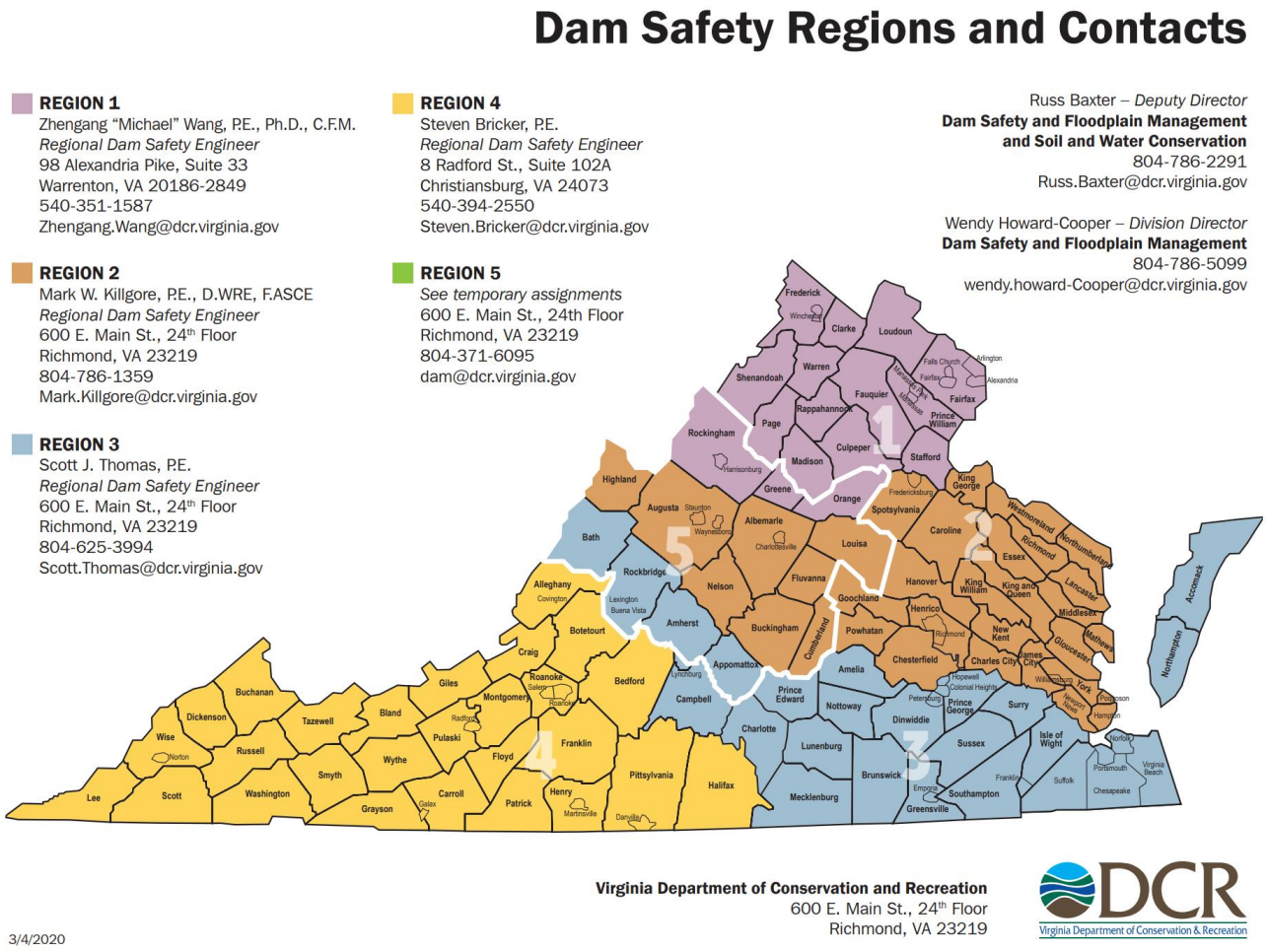

Figure 4-51 Virginia Department of Conservation and Recreation Dam Safety Regions and Contacts Map

(Source: DCR. March 2020) [20]

Virginia Dam Safety Inventory System (DSIS) provides records on over 3,500 dams in Virginia that DCR tracks.[21] Table 4-58 shows the number of dams (impounding structures) per jurisdiction within the CVPDC service area from DSIS. Table 4-59 shows a breakdown of how they are regulated.

Table 4-58 Number of dams per jurisdiction in DSIS within CVPDC area

Jurisdiction	Number of Dams
Amherst County	46
Appomattox County	17
Bedford County	152
Campbell County	34
Lynchburg City	6

[20] https://www.dcr.virginia.gov/dam-safety-and-floodplains/document/dsterrsclr.pdf

[21] Virginia Dam Safety Inventory System (DSIS). https://www.dcr.virginia.gov/dam-safety-and-floodplains/ds-dsis

Table 4-59 Number of dams under each regulation in DSIS within CVPDC area

Regulation	Number of Dams
DCR state regulated	94
Exempt Federal	10
Exempt, Other	1
Exempt, Agriculture	7
Exempt, Size	20
Undetermined	123

4.4.1.2 State Regulated Dams

Unless otherwise exempted (agriculture, mining, etc.), the Virginia Dam Safety Act and the Virginia Impounding Structure Regulations stipulate that a regulated impounding structure is one that is 25 feet or greater in height and creates a maximum impounding capacity of 15 acre-feet or greater; or alternatively, is six (6) feet or greater in height and creates a maximum impounding capacity of 50 acre-feet or greater. Definitions of some of the terms used are as follows:

- "*Height*" means the hydraulic height of an impounding structure, which is the vertical distance from the natural bed of the stream or watercourse measured at the downstream toe of the impounding structure to the top of the impounding structure (*i.e*. dam crest).
- "*Maximum impounding capacity*" means the volume of water or other materials in acre-feet that is capable of being impounded at the top of the impounding structure (*i.e.* dam crest).
- "*Top of the impounding structure*" means the lowest point of the non-overflow section of the impounding structure.

Certain impounding structures may demonstrate qualification and eligibility for an agricultural exemption, thus not needing an operation and maintenance certificate or general permit coverage. Procedure to claim agricultural exemption is in accordance with §10.1-604 of the Code of Virginia, Section 4VAC50-20-165 of the Virginia Impounding Structure Regulations, and DCR guidance document DCR-VSWCB-022. In general, to demonstrate qualification and eligibility for an agricultural exemption the following is necessary:

- The dam must be less than 25 feet in height or it must create a maximum impounding capacity at the top of the impounding structure (*i.e.* dam crest) less than 100 acre-feet;
- The dam must be operated primarily for agricultural purposes. Examples of agricultural purpose use include irrigation for crops or use for livestock purposes;
- Must exhibit compliance with the provisions of DCR guidance document DCR-VSWCB-022 (*Agricultural Exemption Requirements*); and
- Must use/submit DCR Form 199-106 (Agricultural Exemption Report for Impounding Structures) for review and approval.

What does the term "unknown / undetermined" mean in hazard potential classification of dams?

According to Virginia DCR, it was the general definition provided: "Based on the workshop training materials we have defined, at this time, the unknown classification (regulated or non-regulated) as "requires study to be performed by dam owner/engineer and submitted, reviewed, and approved (confirmed) by DCR prior to assignment of final hazard potential classification."

Other information about the dam safety program in the Commonwealth of Virginia can be found on the DCR website.

4.4.1.3 Magnitude/ Severity

The hazard potential classification of dams in Virginia are high, significant, or low. The classification is based on a determination of the effects that a dam failure would likely have on people and property in the downstream area, or inundation zone. Hazard potential classifications descend in order from high to low, high having the greatest potential for adverse downstream impacts in the event of failure. Classification is unrelated to the physical condition of the dam or the probability of its failure. The hazard potential classifications are described by the DCR as follows (Table 4-60):

Table 4-60 Virginia Hazard Potential Classification of Dams [22]

Potential	Description	Inspection
HIGH	Dams that upon failure would cause probable loss of life or serious economic damage	Annual, with inspection by a Virginia-licensed professional engineer every 2 years.
SIGNIFICANT	Dams that upon failure would cause probable loss of life or serious economic damage	Annual, with inspection by a Virginia-licensed professional engineer every 3 years.
LOW	Dams that upon failure would lead to no expected loss of life or significant economic damage. Special criteria: This classification includes dams that upon failure would cause damage only to property of the dam owner.	Annual, with inspection by a professional engineer every 6 years.

(Source: Dam Safety and Floodplains Department, Virginia Department of Conservation and Recreation)

Dams are classified with a hazard potential classification depending on the downstream losses estimated in the event of failure. The recent regulatory revisions, 2008 DCR Dam Safety Impounding Structure Regulations (4VAC50-20-40), bring Virginia's classification system into alignment with the system already used in the National Inventory of Dams maintained by the U.S. Army Corps of Engineers. Hazard potential classification is not related to the structural integrity of a dam, but strictly to the potential for adverse downstream effects if the dam were to fail. Regulatory requirements, such as the frequency of dam inspection, the standards for spillway design, and the extent of emergency operations plans, are dependent upon the dam classification. In accordance with the DCR impounding structure regulations, High Hazard Potential Classification is defined as the following:

"High Hazard Potential is defined where an impounding structure failure will cause probable loss of life or serious economic damage. 'Probable loss of life' means that impacts will occur that are likely to cause a loss of human life, including but not limited to impacts to residences, businesses, other occupied structures, or major roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, major roadways, railroads, personal property, and agricultural interests. 'Major roadways' include, but are not limited to, interstates, primary highways, high-volume urban streets, or other high-volume roadways."

[22] https://www.dcr.virginia.gov/dam-safety-and-floodplains/dam-safety-index

Figure 4-52 illustrates the locations of dams in all hazard potential classifications in the DSIS system within the region. A large percentage of the dams in the CVPDC region have been rated as Low or Significant hazard potential classification. The dam inventory also provides information on the downstream hazard potential, or inundation zone, from a dam failure.

As shown in Table 4-61, of the total dams in DSIS within CVPDC, 23 (9%) dams are considered “High hazard”, 17 (7%) are considered “Significant hazard”, 28 (11%) are considered “Low hazard", and 187 (73%) are considered "Unknown".

Table 4-61 Number of Dams in each Hazard potential category in CVPDC area

Hazard Class	Description	Number of Dams
HIGH, SPECIAL	Virginia-licensed Professional Engineer inspection once a year	1
HIGH	Virginia-licensed Professional Engineer inspection every 2 years	22
SIGNIFICANT	Virginia-licensed Professional Engineer inspection every 3 years	17
LOW	Virginia-licensed Professional Engineer inspection every 3 years	22
LOW, SPECIAL	No future inspection required	6
UNKNOWN	This is common for regulatory status (regulated by DCR) and hazard class. For both hazard class and regulatory status there may be hundreds to thousands of dams that are unknown.	187

(Source: DCR) [23]

[23] https://www.dcr.virginia.gov/dam-safety-and-floodplains/document/dsis-u-guide.pdf

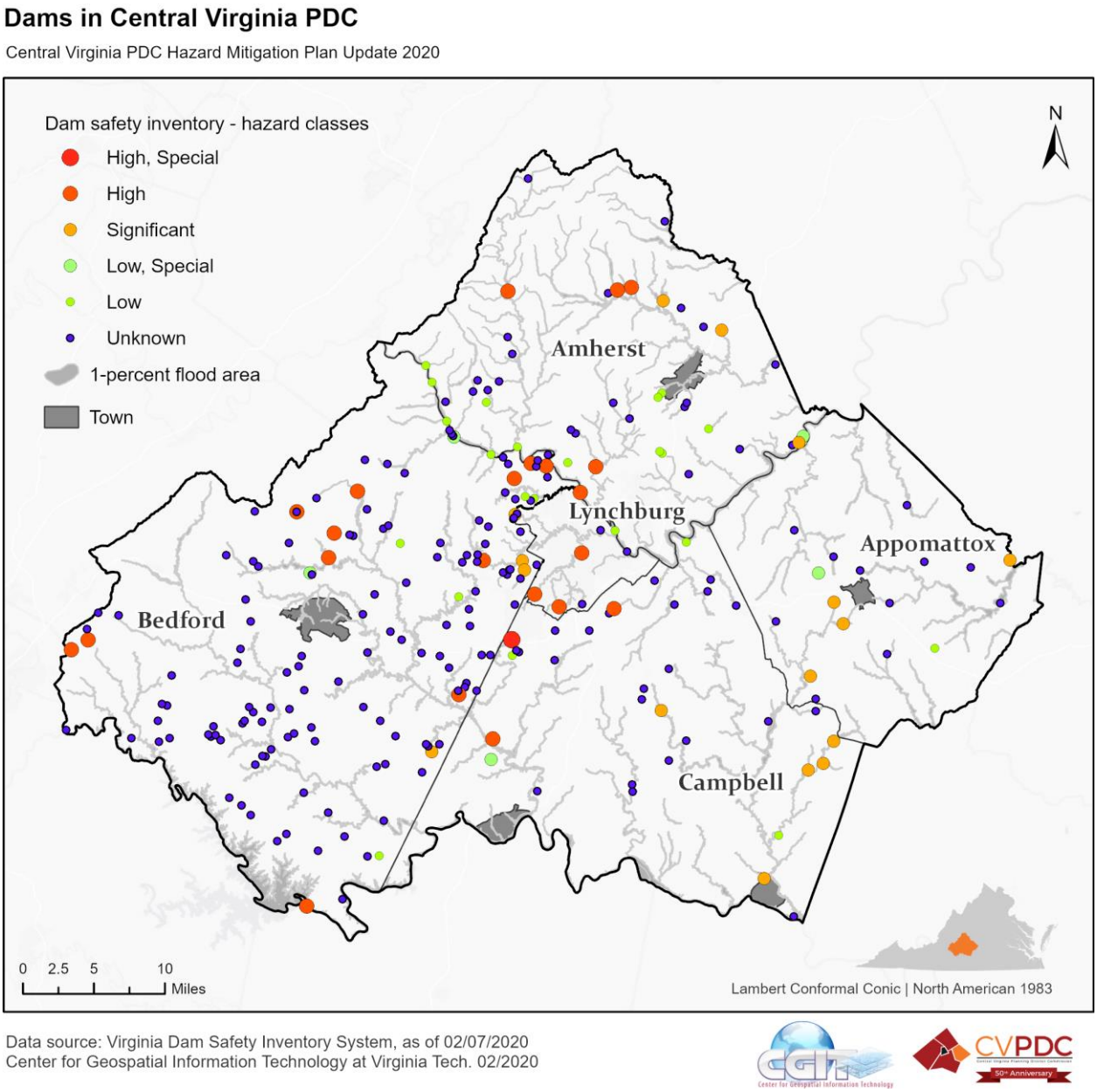

Figure 4-52 Dams in CVPDC. (Source: Virginia Dam Safety Inventory System)

Safety standards become increasingly more stringent as the potential for adverse impact increases. For example, a high hazard potential classification dam -- that is, one whose failure would cause probable loss of human life -- is required to meet higher standards than a dam whose failure would not be as likely to result in such severe adverse consequences. Classification, however, is not static. Downstream conditions, including land use, can and often do change. Although a dam itself may remain relatively stable, it is subject to reclassification if it becomes apparent that a change has occurred in the downstream inundation zone. For example, if new homes or roadways are somehow built in the downstream inundation zone of a Significant hazard potential classification dam, the dam could be reclassified to High hazard potential classification.

A change in hazard potential classification can create a dilemma because, if a dam is reclassified, it usually does not meet the higher standards of the new hazard classification. To meet the required higher standards, the owner of the dam is often required to make modifications or improvements. Any dam that does not meet the most extreme standards of a high hazard dam could become deficient in the future if land use in the downstream inundation zone changes.

To avoid the need for some of these modifications or improvements, all affected parties -- dam owners, engineers, downstream land owners, and local governments -- need to work together. People should be aware of the impacts development downstream can have on the required standards of a dam. It is better and cheaper to address this potential problem beforehand rather than wait and deal with modifications later.

The Virginia Impounding Structure Regulations require the owner of each regulated high, significant, or low hazard potential classification dam to apply for an Operation and Maintenance Certificate. The application must include an assessment of the dam by a professional engineer licensed to practice in Virginia, an emergency plan (EAP - emergency action plan or EPP - emergency preparedness plan), and the appropriate fee(s) and forms, submitted separately. An executed copy of the emergency plan (EAP or EPP) must be filed with the appropriate local emergency official and the Virginia Department of Emergency Management (VDEM).

What is the difference between floodplain maps and dam failure flood inundation maps?

Floodplain maps show the area expected to be inundated by floodwaters due to runoff from a rainfall event of a particular frequency from a riverine source. For example, Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA) typically show the 1-percent-annual-chance (100-year) floodplain and sometimes a 0.2-percent-annual-chance (500-year) floodplain. The 1-percent-annual-chance floodplain is the area inundated by a flood having a 1-percent chance of being equaled or exceeded in a given year. FIRMs are utilized by communities who are participants in the National Flood Insurance Program to guide and regulate development. They are also utilized to determine flood insurance purchase requirements and rates.

Dam failure flood inundation maps show the estimated area expected to be flooded due to a failure or an uncontrolled release from a dam. These maps may consider different failure scenarios such as a non-rainfall-induced failure, also known as a sunny day or fair weather failure, or failure during a rainfall event. Dam failure flood inundation areas can be much larger than the 1-percent-annual-chance floodplain. The flood is more like a wave than a steady current and can have great power and force. Dam failure flood inundation maps, and associated emergency plans (EAP's or EPP's) are utilized by dam owners, engineers, regulators, and emergency managers to determine warning and evacuation areas downstream of a dam. It is important to note that dam failure flood inundation maps do not reflect the safety or integrity of a dam. Dams that meet safety regulations and are operated and maintained well may still have a dam failure flood inundation map.

https://damsafety.org/media/faq

A Regular Operation and Maintenance Certificate for a state regulated impounding structure provides coverage for a period of six years. If a dam has an outstanding issue or deficiency but does not pose imminent danger, a Conditional Operation and Maintenance Certificate can be issued, during which time the dam owner is required to correct the outstanding issue or deficiency. Annual inspection reports by a Virginia-licensed professional engineer or the dam owner (see Table 4-61), must be submitted per the required frequency based on the assigned hazard potential classification to DCR Dam Safety for review and approval.

4.4.1.4 Previous Occurrences

There are no comprehensive databases of historical dam failures or flooding following a dam failure in the CVPDC area. Most failures occur due to lack of maintenance of dam facilities in combination with major precipitation events, such as hurricanes and thunderstorms.

The 1985 Election Day floods occurred in November 1985, when the James River crested at 42.15ft at Holcomb Rock station; 15 James River gauging stations reported new records. The Appalachian Power Co. hydroelectric plant at Reusens Dam was swamped and facilities like the U.S. Pipe and Lynchburg foundry were damaged.[24] After this disaster, the system of James River dams was improved with tributary "wing dams" and gauges upriver to provide more advance notice of onrushing disaster. Another major event in the CVPDC area took place on June 22 and 23, 1995, when the Timberlake Dam in Campbell County failed. Extremely heavy rainfall over the Timberlake basin caused the dam to fail and resulted in two fatalities. Virginia Tech and local National Weather Service office provided a hydrometeorological assessment of this dam failure and the associated flash flood event in "The Timber Lake Dam failure: A hydrometeorological assessment" report. Most recently, there was an overtopping and evacuation event associated with College Lake Dam, City of Lynchburg (Inventory No. 680002) in August of 2018. It was a highly publicized event. A localized precipitation event of 4 to 6 inches within the 21 square mile watershed to the dam/lake resulted in water from high lake levels and adjacent road approach drainage to overtop the top of dam crest 12-18 inches deep and the EAP became activated to Stage Two and then Stage Three. Stage Three required evacuation of approximately 125 people in the downstream impact zone. The dam did not fail. Damage from the overtopping event was repaired along with other minor improvements authorized under an emergency authorization for repair activities. Coverage under a current conditional operation and maintenance certificate requires the dam owner to modify, improve, upgrade, or remove (decommission) the dam accordingly to comply with Virginia Dam Safety program requirements.

4.4.1.5 Relationship to Other Hazards

Figure 4-53 shows the interrelationship (causation, concurrence, *etc.*) between this hazard and other hazards discussed in this plan update.

[24] https://www.newsadvance.com/news/local/from-the-archives-the-flood-of/collection_cb701b48-6861-11e5-a5a0-c783bf39af3e.html#1

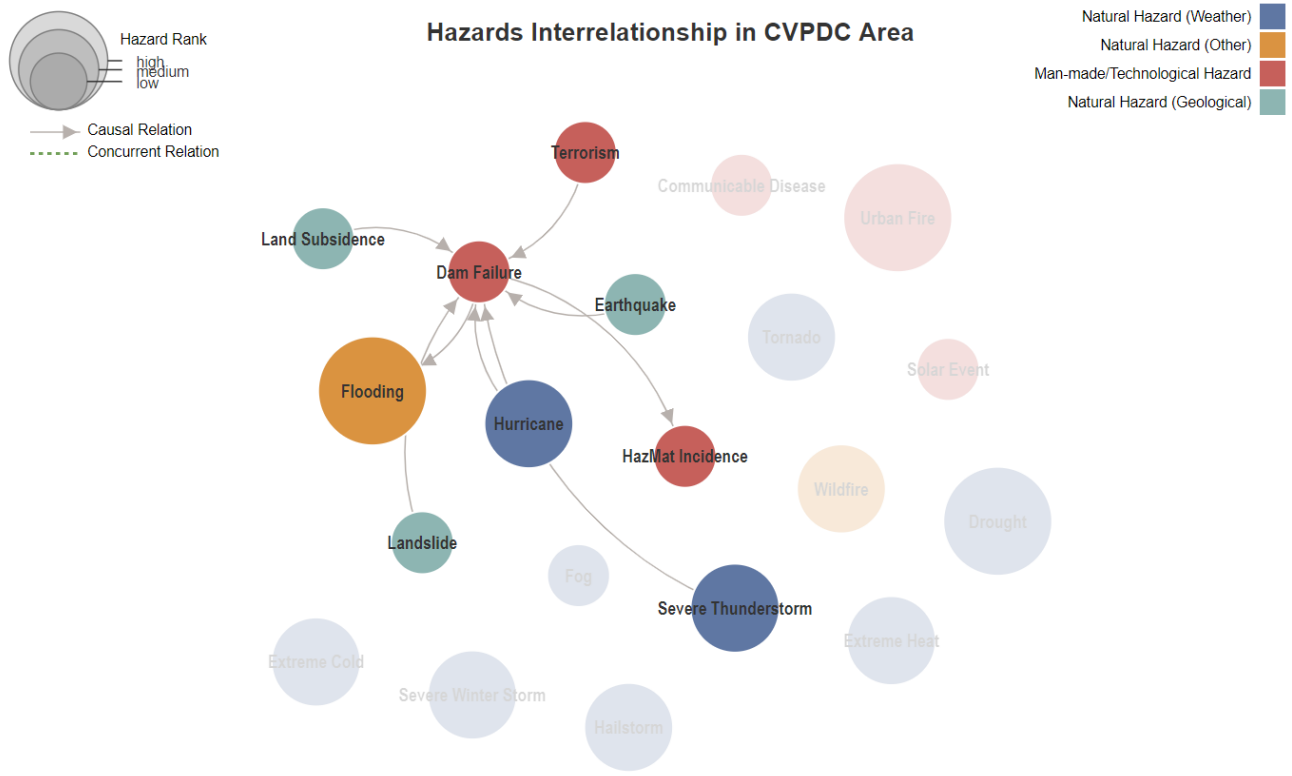

Figure 4-53 Hazards interrelationship

4.4.1.6 Dam failure and other hazards

Dam failures are most likely to happen for one of five reasons: overtopping, foundation defects, cracking, inadequate maintenance and upkeep, and piping.[25] Flood or overtopping is one of the most common causes of dam failure and occurs when the dam's spillway is inadequate for dealing with excess water. During flood events, too much water to be properly handled by the spillway may rush to the dam site and flow over the top of the dam. Improper building construction, including using easily eroded construction materials, also frequently leads to the slow structural failure of dams. This failure can be compounded by underlying geological factors such as porous bedrock that loses structural integrity when saturated. Figure 4-54 and Figure 4-55 summarize the most common causes of dam failure between 2010 and 2017.

[25]Association of State Dam Safety Officials (ASDSO). Dam Failures and Incidents. https://www.damsafety.org/dam-failures

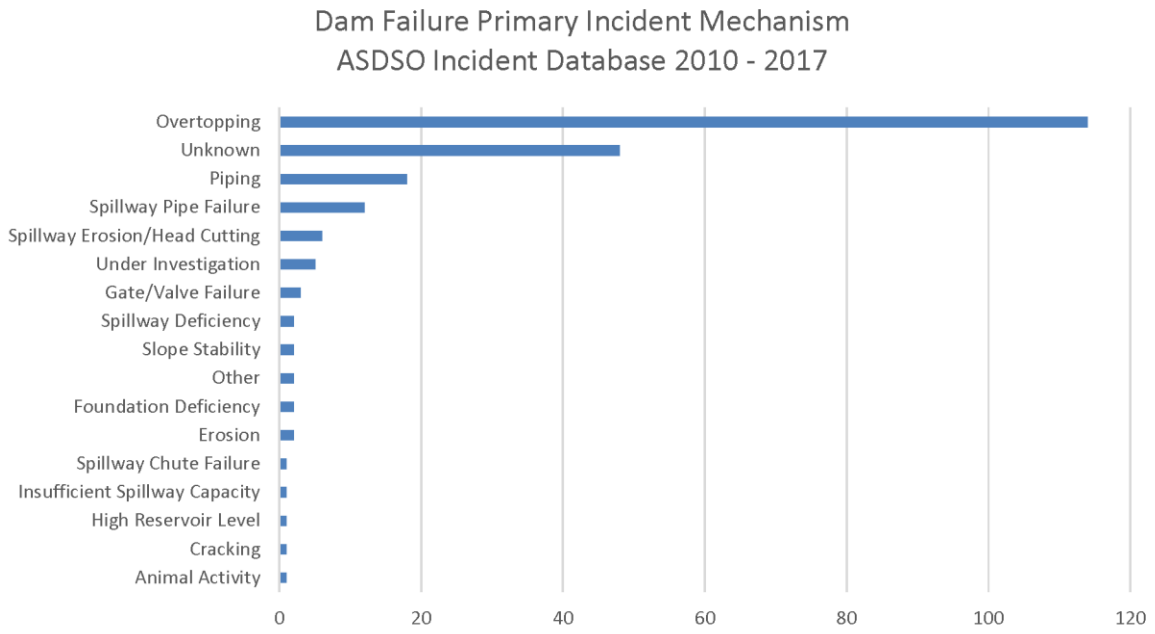

Figure 4-54 Dam failure primary incident mechanism (Source: ASDSO Incident Database, 2010 - 2017) [26]

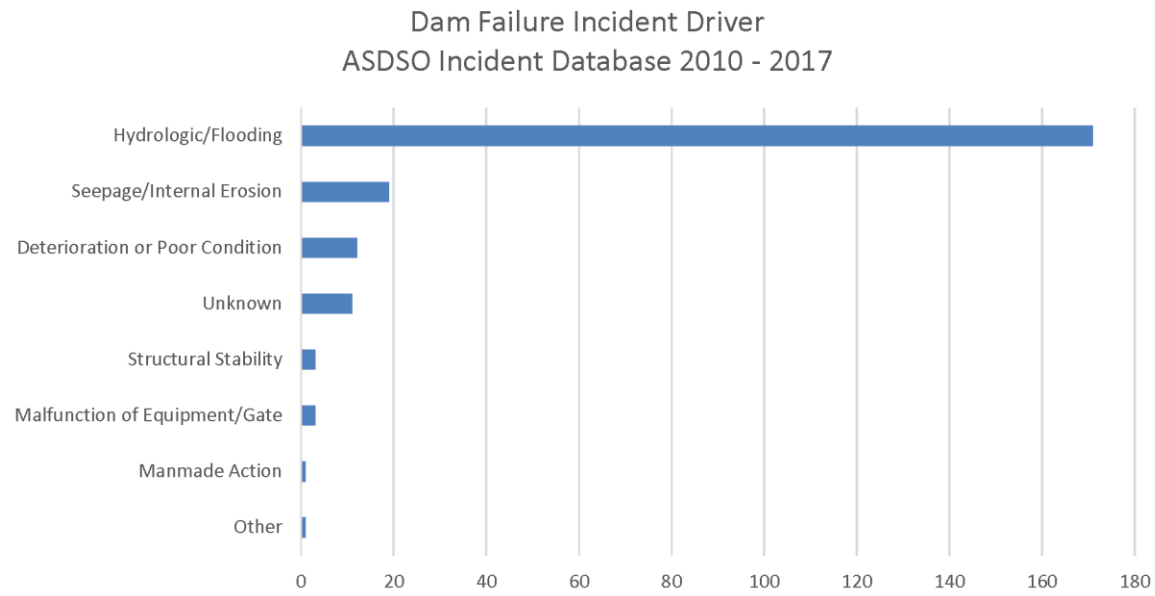

Figure 4-55 Dam failure incident driver (Source: ASDSO Incident Database, 2010 – 2017)

[26] The dam failure incident data derive from the ASDSO Dam Incident Database, dam failure incidents for the years 2010 through 2017. Incident data mostly obtained from the state dam safety programs and/or media reports. The incident data is not inclusive of all dam safety incidents.

The many causes of dam failures are commonly summarized using five types of failure modes: hydrologic, geologic, structural, seismic, and human-influenced (refer to Table 4-62).

Table 4-62 Typical Dam Failure Modes

Failure Mode	Examples of dam failures
Hydrologic	Overtopping due to: • Inadequate spillway design • Blocked spillway • Loss of freeboard* due to embankment settlement or erosion • Structural overstressing of dam components
	Surface erosion due to: • High velocity water • Wave action
Geologic	Piping and internal erosion caused by: • Internal cracking, hydraulic fracture, or differential settlement • Inadequate filters • Outlet pipeline failure • Pipes through the embankment formed by roots or animal/insect burrows
	Slope instability and hydraulic fracturing: • Load exceeds sliding resistance at base or at joints of structure
Structural	Concrete dam: Failure of critical structural components Embankment dam: Failure of the upstream or downstream face
Seismic	Earthquakes/ground movement; also liquefiable foundations or embankment materials
Human influenced or caused	Misoperation: • Sudden rise in reservoir level causes flow through transverse cracks in embankment • Incidents including gate failures, power interruption etc.
	Terrorist activities: • Purposeful misoperation of the dam • Impact of object that removes part of the dam crest

**Freeboard = Vertical distance between a specified stillwater (or other) reservoir surface elevation and the top of the dam, without camber (FEMA, 2004a)* [27]

Extreme rainfall or snowmelt events that can lead to natural floods of variable magnitude could induce landslides. Landslides pose two threats to dams, both upstream from the dam and at the dam site itself. At the dam site, a landslide could completely wipe out the dam from its foundation. A landslide upstream has the potential to send a wave of water surging towards the dam, quite possibly causing an overtopping event. Terrorist attacks are also another concern for dam safety. The terrorist activities can range from purposeful misoperation of the dam to physical attacks on the structure itself.

Earthquakes are also a major threat to dams, though it is very rare that a dam will be completely destroyed by an earthquake. In the event of total failure, the most common cause is the liquefaction of fill along the dam

[27] https://damsafety.org/sites/default/files/FEMA%20Federal%20Guidelines%20InundatnMap%20P946.pdf p4-3.

wall. Almost all of the high hazard dams in the CVPDC area are located between the Central Virginia seismic zone (CVSZ) and the Giles County seismic zone (GCSZ), an area of normally low seismic activity.

No matter what the cause of dam failure, the aftermath of such an event can range from moderate to severe. It is likely that the failure of major dams will cause widespread loss of life downstream to humans and animals, as well as extreme environmental stress along the flood path. Water supplies upstream could be left completely dry, while water supplies downstream are overrun or contaminated with debris from the ensuing flood.

4.4.2 Impact and Vulnerability

Dam failure has the potential to cause direct or indirect economic impacts, significant and long-term social effects, and negative environmental impacts. Impounded water upstream of a dam when released uncontrollably, may threaten lives in the flow path downstream or cause damage to homes, roads, bridges, and any other infrastructure in its way. Direct economic impacts appear immediately following a dam failure and typically include the need to repair and rebuild structures and infrastructure and reopen businesses. Indirect economic impacts may include unemployment leading to population shifts, difficulty in attracting new business to the area, lower local property tax revenues, etc. Social impacts may include changes in quality of life in the affected community, loss in the public's confidence in public officials, difficulty delivering resources and services to the community, etc. Environmental impacts of dam failure may include the pollution of surface or groundwater, air, and soil; the release of hazardous materials; or the destruction of environmentally sensitive areas. [28]

The American Society of Civil Engineers' 2017 Infrastructure Report Card detailed the importance of public safety and proper maintenance:

"*In order to improve public safety and resilience, the risk and consequences of dam failure must be lowered. Progress requires better planning for mitigating the effects of failures; increased regulatory oversight of the safety of dams; improving coordination and communication across governing agencies; and the development of tools, training, and technology. Dam failures not only risk public safety, they also can cost our economy millions of dollars in damages. Failure is not just limited to damage to the dam itself. It can result in the impairment of many other infrastructure systems, such as roads, bridges, and water systems. When a dam fails, resources must be devoted to the prevention and treatment of public health risks as well as the resulting structural consequences.*"

4.4.3 Risk Assessment and Jurisdictional Analysis for High Hazard Dams

4.4.3.1 Amherst County and Town of Amherst

According to DCR DSIS inventory, there are a total of 46 dams within Amherst County. Of those dams, 5 (11%) are classified as high hazard potential dams, and 23 dams have unknown/undetermined status (Figure 4-56, Table 4-63). Although there are no high hazard (or other) dams in the Town of Amherst, there may be impacts if a high hazard dam fails.

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28 https://damsafety.org/sites/default/files/files/FEMA%20TM%20AssessingtheConsequencesofDamFailure%20March2012.pdf

4.4.3.1.1 Principal Dam Breach Problems

The following issues have been identified for dam failure scenarios in Amherst County (also see Table 4-64):

- Pump station at Route 718 / Buffalo River
- Henry L. Lanum Water Treatment Plant
- Norfolk Southern Railroad impacts
- Several road, bridge, and culvert impacts
- Several residences and businesses in the maximum inundation area
- Inundation areas not all readily available in a Geographic Information System (GIS) format for high hazard dams

Table 4-63 Number of Dams in each Hazard Potential Category within Amherst County, Virginia.

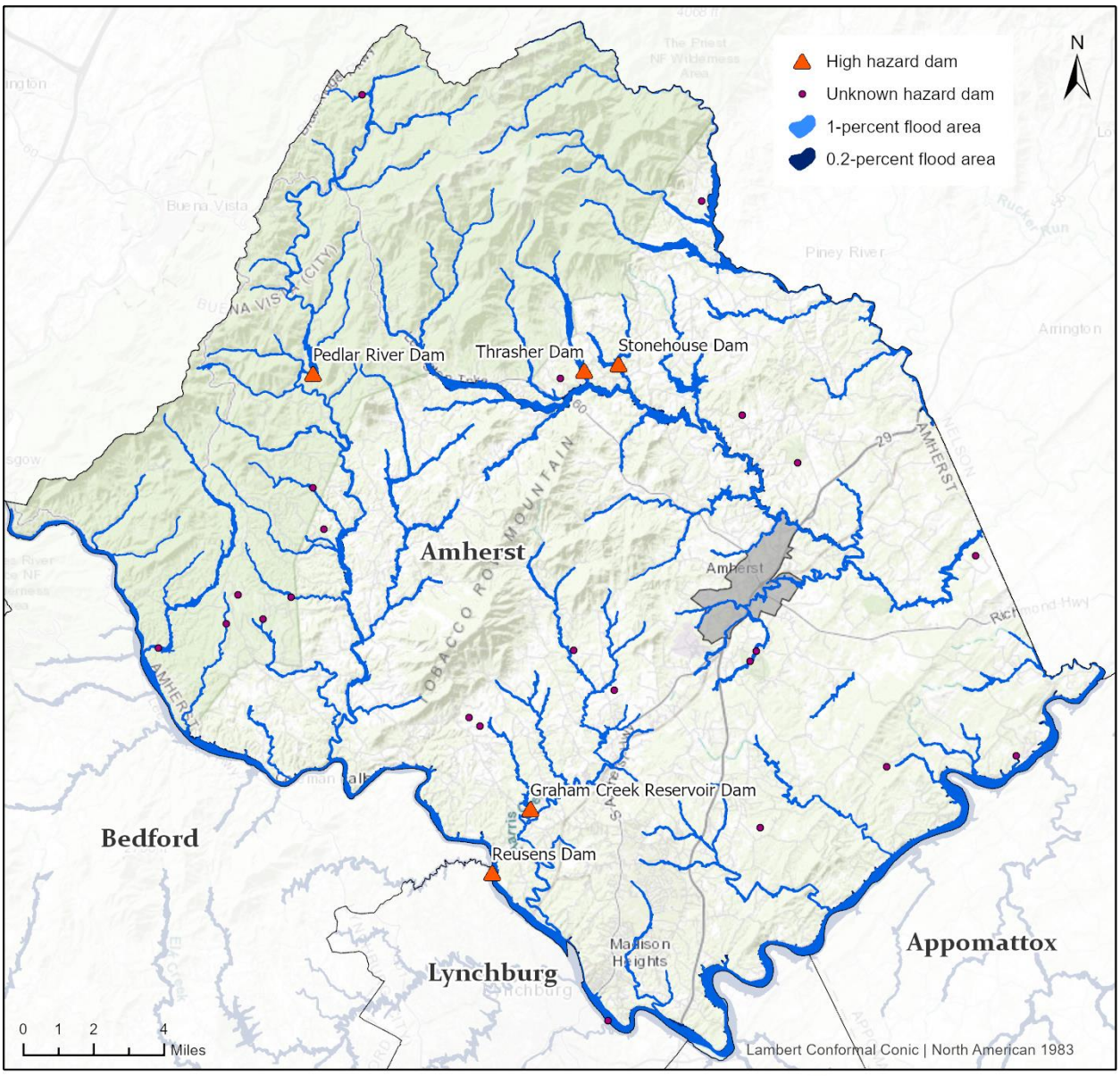
Hazard Potential	Number of Dams
HIGH	5
HIGH, SPECIAL	0
SIGNIFICANT	4
LOW	12
LOW, SPECIAL	2
UNKNOWN	23

Table 4-64 Critical facility and infrastructure in dam failure inundation zone within Amherst County

Facility Name	Facility Type	Address	Coordinates	Floodplain	Inundation Zone
Electrical Substation	Electrical Substation	127 Stonewall St, Lynchburg	37.4622, -79.1872	1%, 0.2%	Reusens Dam
Lanum Water Filtration Plant	Wastewater Treatment Plant	1355 Elon Rd, Madison Heights	37.4846, -79.1664	1%, 0.2%	Graham Creek Reservoir Dam
Sewer Pump Station	Sewer Pump Station	Route 718 / Buffalo River	37.6091, -79.0384	1%, 0.2%	Thrasher Dam and Stonehouse Dam

High and Unknown Hazard Dams in Amherst County, Virginia

Central Virginia PDC Hazard Mitigation Plan Update 2020



Data source: Virginia Dam Safety Inventory System, as of 02/07/2020
Center for Geospatial Information Technology at Virginia Tech. 02/2020

Figure 4-56 Location of high and unknown hazard dams in Amherst County and Town of Amherst, Virginia.

4.4.3.1.2 Risk Analysis of Individual Dam

Thrasher Dam

General information

The Thrasher Dam (aka. Buffalo River Dam #2) is operated by the Public Works Department in Amherst County. The dam is a 74.5 foot tall impounding structure, located on Thrasher Creek, a tributary to Buffalo River, in Amherst County, Virginia, approximately 8 miles northwest of Amherst, VA. From the dam, Thrasher Creek flows south approximately 0.5 miles before joining Buffalo River. Buffalo River continues southeastward joining Tye River, and then James River after approximately 30 miles.

The site is located at the end of Thrashers Lake Road (Route 829), Amherst Virginia 24521. The dam is classified as a High Hazard Dam as determined by the hazard classifications performed by Hurt and Proffitt. It creates a 36-acre impoundment used for recreation and flood control. The drainage area is approximately 4,352 acres, or 6.8 square miles. The reservoir flood capacity storage is 2,562 acre-feet at the emergency spillway crest, at elevation 748.5 feet.

The United States Department of Agriculture (USDA) Soil Conservation Service designed and funded construction of the dam. The dam was built by E.W. Yeatts, Inc. in 1977. The inundation maps were developed on April 19, 2013 by Hurt & Proffitt.

Dam break inundation zone

"Dam break inundation zone (DBIZ)" means the area downstream of a dam that would be inundated or otherwise directly affected by the failure of a dam (DCR, 2016).[29] According to DCR-VSWCB-038, §10.1-606.2, Mapping of Dam Break Inundation Zones: An owner of an impounding structure shall prepare a map of the dam break inundation zone for the impounding structure in accordance with criteria set out in the Virginia Impounding Structure Regulations (4VAC50-20)

Figure 4-57 is an overview of the inundation zone map for the Probable Maximum Flood (PMF) of Thrasher Dam. The upstream inundation zone caused by the dam is primarily farmland and wooded areas. No occupied structures are in the upstream inundation area. There are multiple roads that parallel or cross the river downstream of the dam and will be affected by a Probable Maximum Flood (PMF) event and a subsequent failure of the dam. The PMF is defined as the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area. Downstream of the dam, Thrashers Creek flows through agricultural lands. The creek passes through a culvert under Sandidges Road and continues on to Buffalo River. In addition, there are multiple residences and business structures downstream of the dam that would be inundated by a PMF storm. During a dam failure or flood event, bridges and culverts may be adversely impacted. The roads should be closed off to ensure that no one is harmed during a culvert/bridge failure. Prior to reopening the road, Virginia Department of Transportation (VDOT) should be contacted to inspect the bridges and roads. No unauthorized personnel should be allowed on site.

[29] https://www.dcr.virginia.gov/form/dcr-vswcb-038.pdf

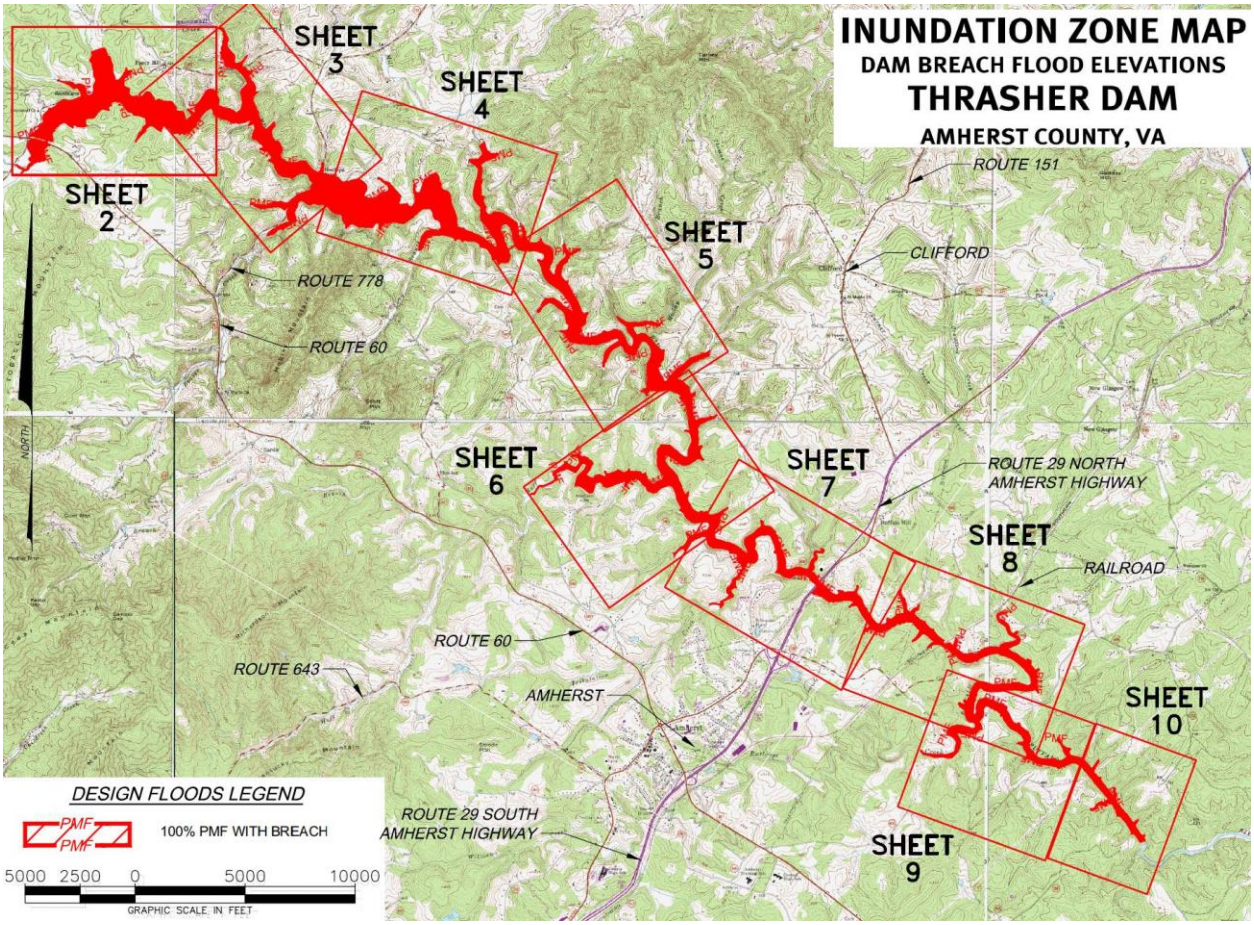


Figure 4-57 Inundation zone map of Thrasher Dam. (Source: Virginia DCR)

Vulnerable structures

The following road bridges may be impacted during a dam breach scenario (Table 4-65). One sewer pump station at Route 718 / Buffalo River is inside the common inundation areas of both Thrasher Dam and Stonehouse Dam. One sewer pump station is located in the dam breach inundation zone (Table 4-66).

Table 4-65 Vulnerable road bridges in dam breach zone of Thrasher Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Lowesville Road	Buffalo River	0.00-Rt 617N/0.20-Rt 617S	-79.10312	37.65442	1%, 0.2%
Amherst Highway	Buffalo River	0.00-Rt.608 / 0.60-Rt.739'	-79.02645	37.60525	1%, 0.2%
Campbells Mill Rd.	Branch of Buffalo River	0.15-Rt. 29 / 2.35-Rt.736	-79.02740	37.60700	1%, 0.2%
Turkey Mtn Rd	Mill Creek	2.99-Rt.738 / 0.60-Rt.645	-79.07860	37.65650	1%, 0.2%
Sandidges Road	Stonewall Creek	.40-Rt 625 / .10-Rt 617	-79.11534	37.66772	1%, 0.2%
Sandidges Road	Thrashers Creek	0.50-Rt.617/0.60-Rt.632	-79.13497	37.66575	1%, 0.2%

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Poor House Farm Rd	Beaver Creek	.02-Rt 778 / 2.28-Rt 692	-79.10488	37.65224	1%, 0.2%
Boxwood Farm Road	Turner Creek	.70 Rt 658 / 1.06 Rt 822	-78.99573	37.59901	1%, 0.2%
Boxwood Farm Road	Buffalo River	.64 Rt 822 / 1.18 Rt 658	-79.00480	37.59684	1%, 0.2%
Lexington Tpke.	Stream	7.47 Amh WCL/0.00 Rt 610	-79.14728	37.65913	0.2%
Lexington Turnpike	Buffalo River	7.27-WCL Amh/.15-Rt.610	-79.14483	37.65870	1%, 0.2%
NBL Route 29	Buffalo River	0.85-RT 608 0.62-RT 29 B	-79.02603	37.60531	1%, 0.2%

Table 4-66 Vulnerable facilities and infrastructures in dam breach zone of Thrasher Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Sewer Pump Station	Sewer Pump Station	Route 718 / Buffalo River	Amherst	-79.0384	37.6091	1%, 0.2%

Stonehouse Dam

General information

The Stonehouse Dam (aka. Buffalo River Dam #3) is a 63.6 foot tall impounding structure, designed primarily for flood control in 1978 by the USDA Soil Conservation Service. It is located on Stonehouse Creek, a tributary to Buffalo River, in Amherst County approximately 8 miles northwest of the Town of Amherst. From the dam, Stonehouse Creek flows south approximately 0.8 miles joining Buffalo River. Buffalo River continues southeastward approximately 15 miles to James River.

Dam break inundation zone

Figure 4-58 is an overview of the inundation zone map for the PMF of Stonehouse Dam. The upstream inundation zone caused by the dam is primarily farmland and wooded areas. No occupied structures are in the upstream inundation area. There are multiple streets and residences in the study area, downstream of the dam, that are subject to inundation for the dam breach scenario.

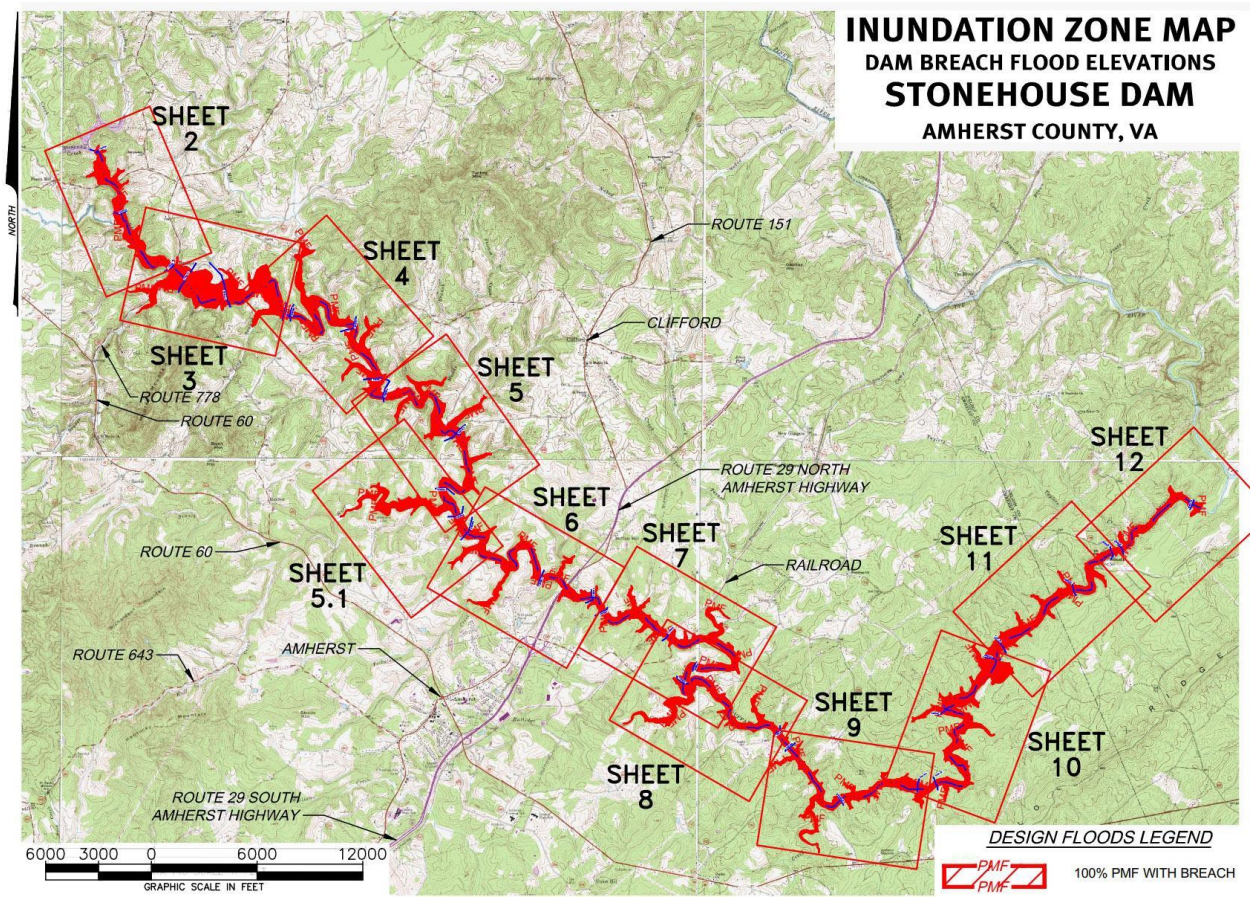


Figure 4-58 Inundation zone map of Stonehouse Dam. (Source: Virginia DCR)

Vulnerable structures

During the dam breach event, several roads and structures downstream of the dam may be impacted. These include Sandidges Road (Route 610), Fancy Hill Road (Route 617), Lowesville Road (Route 778), Poor House Farm Road (Route 617), Winton Road (Route 736), Campbell's Mill Road (Route 608), North Amherst Highway (Route 29), South Amherst Highway (Route 29), Boxwood Farm Road (Route 739), Lexington Turnpike (Route 60), and Tye River Road (Route 657) as well as Norfolk Southern Railroad tracks (79.00705°W 37.59809°N) in the affected area.

The following road bridges may be impacted during a dam breach scenario (Table 4-67).

Table 4-67 Vulnerable road bridges and tunnels in dam breach zone of Stonehouse Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Lowesville Road	Buffalo River	0.00-Rt 617N/0.20-Rt 617S	-79.1031	37.65442	1%, 0.2%
Amherst Highway	Buffalo River	0.00-Rt.608 / 0.60-Rt.739	-79.0264	37.60525	1%, 0.2%
Campbells Mill Rd.	Branch of Buffalo River	0.15-Rt. 29 / 2.35-Rt.736	-79.0274	37.607	1%, 0.2%
Turkey Mtn Rd	Mill Creek	2.99-Rt.738 / 0.60-Rt.645	-79.0786	37.6565	1%, 0.2%
Sandidges Road	Stonewall Creek	.40-Rt 625 / .10-Rt 617	-79.1153	37.66772	1%, 0.2%

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Poor House Farm Rd	Beaver Creek	.02-Rt 778 / 2.28-Rt 692	-79.1049	37.65224	1%, 0.2%
Boxwood Farm Road	Turner Creek	.70 Rt 658 / 1.06 Rt 822	-78.9957	37.59901	1%, 0.2%
Boxwood Farm Road	Buffalo River	.64 Rt 822 / 1.18 Rt 658	-79.0048	37.59684	1%, 0.2%
NBL Route 29	Buffalo River	0.85-RT 608 0.62-RT 29 B	-79.026	37.60531	1%, 0.2%

Graham Creek Reservoir Dam

General information

Graham Creek Reservoir Dam is located on Graham Creek in Amherst County, which is a tributary to Harris Creek, which flows into James River approximately 7 miles below the dam near the City of Lynchburg, Virginia. The location is north of Elon Road (Route 130) and west of the Henry L. Lanum Jr. Water Filtration Plant, in Madison Heights, Virginia 24502. The dam was built in 1967 as a water supply storage reservoir and is operated by Amherst County Service Authority. The normal pool elevation was raised by 6 feet in 2003 to increase storage capacity. Downstream of the dam, Graham Creek flows through agricultural and residential areas.

Dam break inundation zone

Inundation maps were developed as part of the Incremental Damage Assessment for Amherst County Graham Creek Reservoir Dam prepared on April 22, 2013 by Hurt & Proffitt. Figure 4-59 is an overview of the maps for the PMF event. During PMF storm events, the dam is overtopped by 9.6 feet and structures downstream of the dam will be impacted.

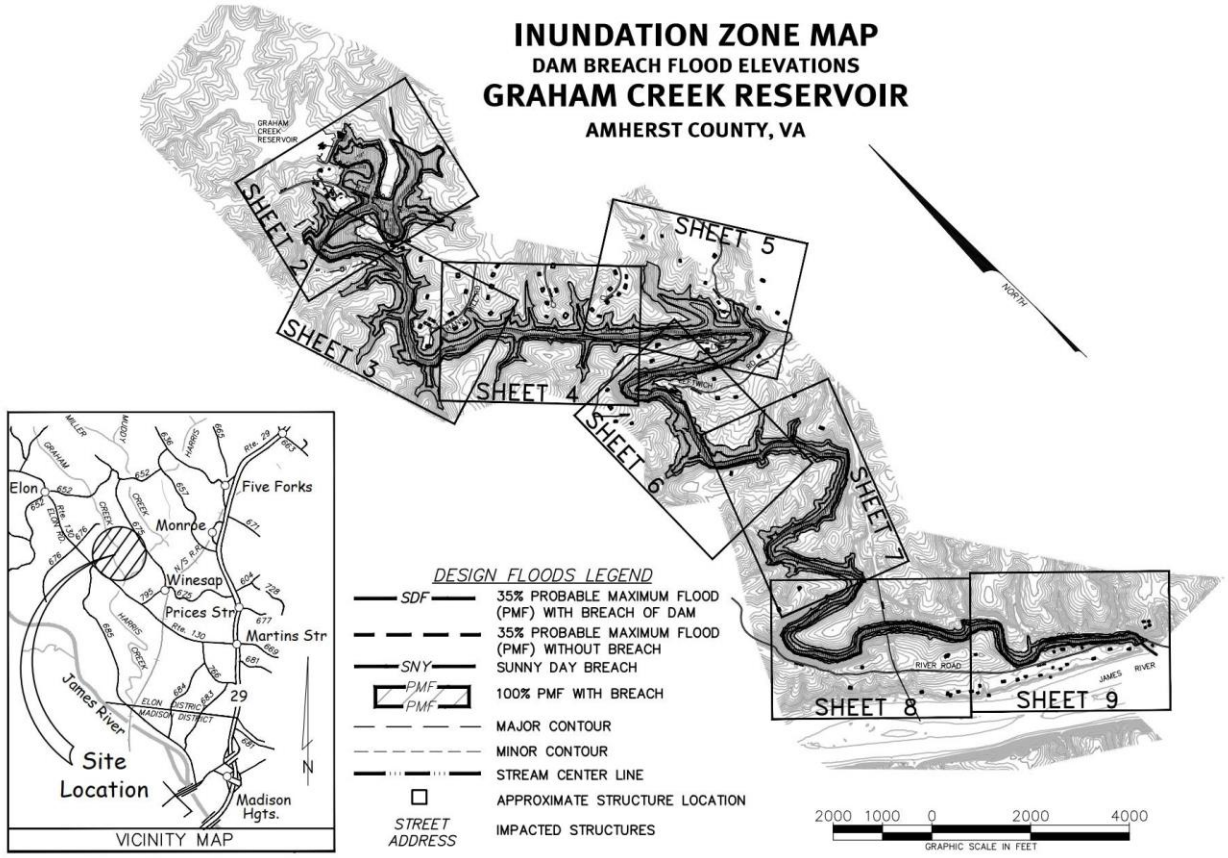


Figure 4-59 Inundation zone map of Graham Creek Reservoir Dam. (Source: Virginia DCR)

Vulnerable structures

The dam hazard classification study indicates some structures may be impacted in the unlikely event of failure of the Graham Creek Reservoir Dam, as a dam break or flooding caused by large runoff. The Henry L. Lanum Water Treatment Plant, Hundley Lane, Route 130, and Norfolk Southern Railroad tracks (79.16244°W 37.44904°N) will be inundated during a PMF event (

Table 4-69). The following road bridges may be impacted (Table 4-68).

Table 4-68 Vulnerable road bridges and tunnels in dam breach zone of Graham Creek Reservoir Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Elon Road	Harris Creek	0.45-Rt.795 / 0.80-Rt 704	-79.16532	37.48489	No
Elon Road	Graham Creek	0.65 Rt 704/0.60 Rt 795	-79.16612	37.48628	1%, 0.2%
River Road	Harris Creek	0.30-Rt 684/4.99-Rt 130	-79.15073	37.43892	1%, 0.2%

Table 4-69 Vulnerable facilities and infrastructures in dam breach zone of Graham Creek Reservoir Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone

Lanum Water Filtration Plant	Water Treatment Plant	1355 Elon Rd	Madison Heights	-79.1664	37.4846	1%, 0.2%

Pedlar River Dam

General information

Pedlar River Dam in Amherst County was initially constructed in 1904. It is a primary water source for the residents of Lynchburg and is operated and maintained by the City of Lynchburg. The spillway was raised in 1926 and the entire dam was raised in 1931 and again in 1964. Flow over the spillway discharges to Pedlar River. It is regulated by the Virginia Department of Conservation and Recreation Dam Safety Division.

Dam break inundation zone

Figure 4-60 provides an overview of the inundation zone of Pedlar River Dam from the dam breach inundation study completed by Black & Veatch in February 2008.

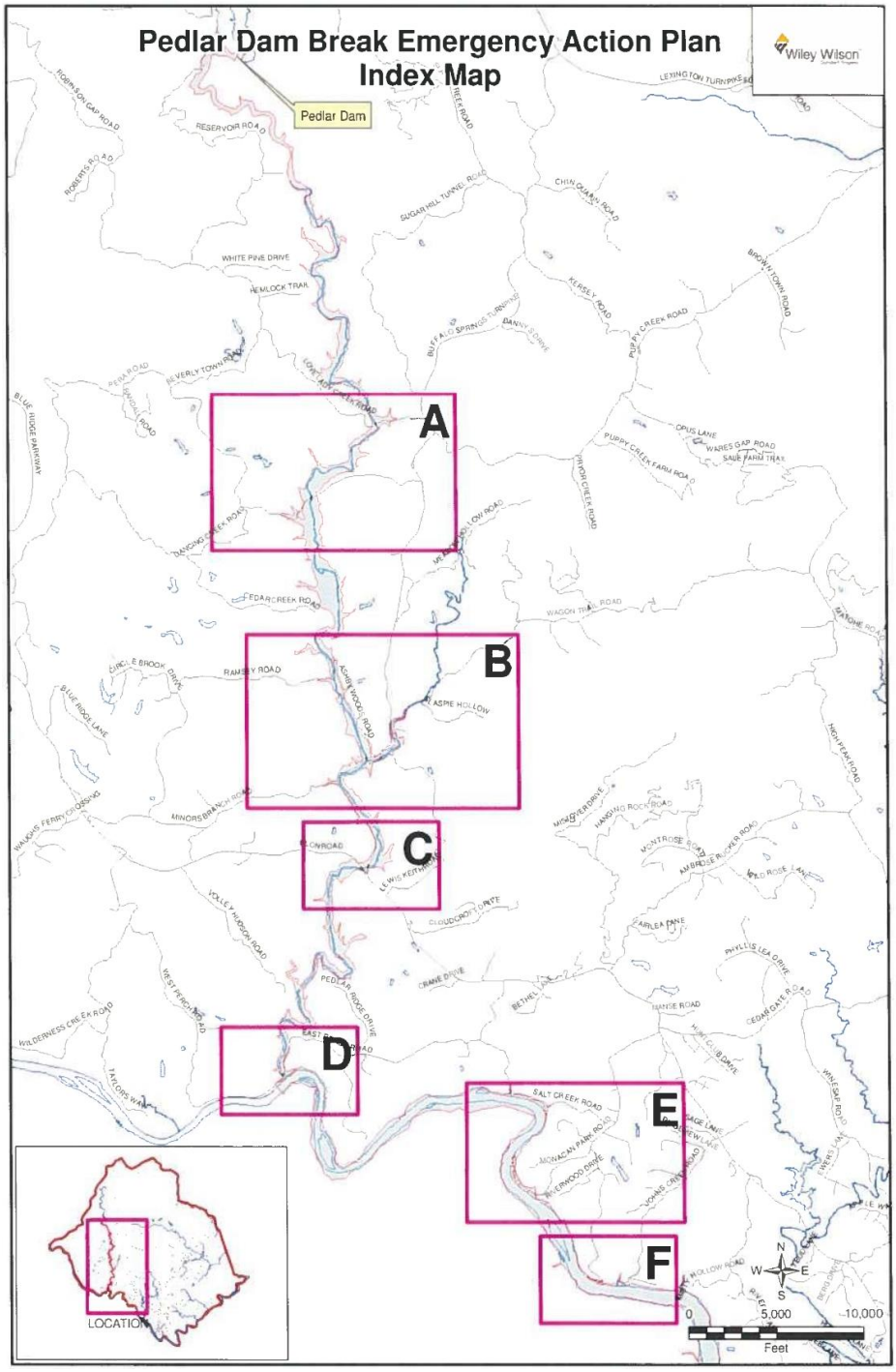


Figure 4-60 Inundation zone map of Pedlar River Dam. (Source: Virginia DCR)

Vulnerable structures

Some roads and road bridges downstream of Pedlar River Dam may be impacted during a dam breach event. Ashby Woods Road (Route 643), Salt Creek Road along James River (Route 787), Monacan Parkway along James River (Route 652), and Reservoir Road are within the inundation zone. Norfolk Southern Railroad tracks along

the south bank of James River may be inundated during a PMF event. Part of Route C, Reservoir Road (Forest Service Road 39), passes through the Pedlar River valley upstream of the reservoir and may be flooded during storms. Table 4-70 and Table 4-71 list several road bridges and two power plants that may be impacted.

Table 4-70 Vulnerable road bridges and tunnels in dam breach zone of Pedlar River Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Dancing Creek Road	Pedlar River	1.40-Rt 635 / 1.00-Rt 641	-79.26391	37.60045	1%, 0.2%
Buffalo Springs Tpke	Pedlar River	0.08-Rt 130/0.01-Rt 702	-79.25239	37.54261	1%, 0.2%
Buffalo Springs Road	Pedlar River	0.40-Rt 647/0.06- Rt.643	-79.25299	37.55951	1%, 0.2%
Love Lady Creek Road	Pedlar River	0.58-Rt 635/ 2.14-Rt 607	-79.25131	37.61209	No
Ramsey Road	Pedlar River	0.00-Rt 643/3.70-Rt 647	-79.25922	37.57339	1%, 0.2%
East Perch Road	Pedlar River	1.10-Rt.691/3.90-Rt.695	-79.26881	37.50983	1%, 0.2%
Wagon Trail Road	Horsleys Creek	.10 - Rt 651/.10 - Rt 635	-79.24792	37.56421	1%, 0.2%

Table 4-71 Vulnerable facilities and infrastructures in dam breach zone of Pedlar River Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Holcomb Rock Dam Hydro Plant	Energy Facility	4839 Holcomb Rock Road	Bedford	-79.2628	37.5036	1%, 0.2%
Coleman Falls Dam Hydro Plant	Energy Facility	6007 Lee Jackson Hwy.	Bedford	-79.3006	37.5021	1%, 0.2%

Reusens Dam (Judith Dam)

General information

Reusens Dam originally was called Judith Dam when it was built in 1851 by the James River and Kanawha Company. It is located on James River at River Mile 260 near the northern limits of the City of Lynchburg, Virginia. It was modified in 1924 and was operated by the Appalachian Power Company between 1924 and 2017. It is now owned and operated by Eagle Creek Renewable Energy.[30] The dam is an exempt federal dam.

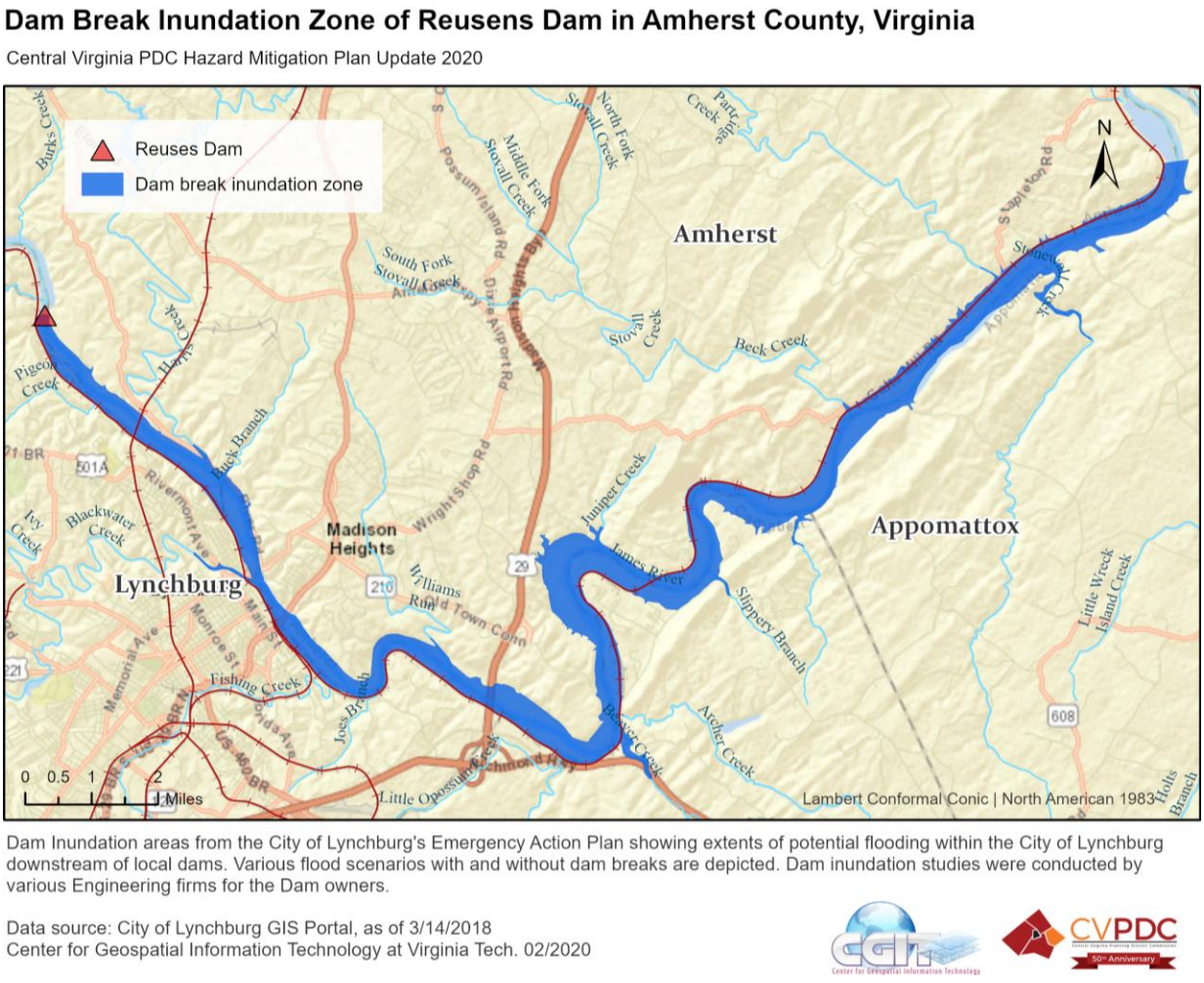
The reservoir formed by Reusens Dam has a surface area of 500 acres and gross storage capacity of 6,869 acre-feet. The drainage area to the reservoir is approximately 3,275 square miles (about one-third of the drainage basin for the entire James River). Drainage to Reusens Reservoir begins at the headwaters in the Allegheny Mountains and passes through the Valley and Ridge and Blue Ridge Provinces. Reusens Dam lies just east of the Blue Ridge Province within the Piedmont Upland section. Immediately surrounding Reusens Reservoir, the drainage area has approximately 1,200 feet of relief and is indicative of the eastern portion of the Blue Ridge Province. Runoff for the most part emanates from forested and agricultural areas.

[30] Appalachian Power completes sale of hydroelectric plant near Lynchburg. April 13, 2017. The Roanoke Times. https://www.roanoke.com/business/news/bedford_county/appalachian-power-completes-sale-of-hydroelectric-plant-near-lynchburg/article_1274e09c-7f33-5ffa-8d2f-99be62c7f98a.html

Dam break inundation zone

The dam-break flood inundation zone of Reusens Dam was developed by Black & Veatch based upon a simulated failure of the dam during the 1985 flood-of-record. Figure 4-61 is an overview of the inundation zone map for the PMF of the dam. The digital format of the inundation zone boundary was provided by the City of Lynchburg GIS Portal.[31]

Reusens Dam sits downstream of the U.S. Army Corps of Engineers' Gathright Dam and several smaller reservoirs. There are no dams located downstream of this structure which could be operated to store flood flows. Downstream of the dam and powerhouses, runoff from urban areas becomes more predominant due to the proximity of the City of Lynchburg. Forest land accounts for approximately 70% of the land use in the drainage basin, with forest cover being primarily of the oak-chestnut type. Other land uses include cropland (13%), pasture (11%), urban (4%), and other miscellaneous uses (2%).



Dam Inundation areas from the City of Lynchburg's Emergency Action Plan showing extents of potential flooding within the City of Lynchburg downstream of local dams. Various flood scenarios with and without dam breaks are depicted. Dam inundation studies were conducted by various Engineering firms for the Dam owners.

Data source: City of Lynchburg GIS Portal, as of 3/14/2018
Center for Geospatial Information Technology at Virginia Tech. 02/2020

Figure 4-61 Inundation zone map of Reusens Dam. (Source: City of Lynchburg GIS Division)

[31] Know My Zone! Flood and Dam Inundation Zone Look Up - Map. https://www.arcgis.com/home/item.html?id=aea88b27b83943caa6a86b5411c475c5

Vulnerable structures

Some road bridges in the downstream of Reusens Dam may be impacted during a dam breach scenario (Table 4-72). Roads including South Amherst Highway (Route 29), Monacan Parkway (Route 652), and Richmond Highway (Route 60) along James River may be impacted during a PMF event. Atlantic, Mississippi, and Ohio Railroad (AM&O) Jefferson Street Tunnel and Norfolk Southern Railroad tracks along James River may be inundated. The Amazement Square Child Museum, 4 electric substations, several hazmat or energy facilities near the south bank of James River, Six Mile Bridge (historic site) in Campbell County are also within (or partially in) the inundation zone (Table 4-73).

Table 4-72 Vulnerable road bridges and tunnels in dam breach zone of Reusens Dam

Road Name	Crossing	Bridge / Tunnel Location	Lon	Lat	In flood zone
460 EBL	Beaver Creek	0.50-Rt.726/0.85-Rt.662	-79.05480	37.38518	1%, 0.2%
Cottontown Rd./621	Ivy Creek	.40-RTE 1240;.25-RTE 884	-79.26179	37.39696	1%, 0.2%
Cranehill Drive	Ivy Creek	0.35LINKHORN/0.01LANG HORN	-79.19012	37.41823	No
Galts Mill Road	Beck Creek	2.58-Rt 664 / 0.00-Rt 648	-79.01101	37.44757	1%, 0.2%
Galts Mill Road	Partridge Creek	2.30-Rt.648/0.01-Rt.624	-78.97794	37.46973	1%, 0.2%
Hawkins Mill Road	IVY CREEK	1.55-RTE 659;0.70-RTE 621	-79.26113	37.40342	1%, 0.2%
Hawkins MillRd 659	Howards Mill Creek	1.00 Lynchburg; 0.50 Rt 660	-79.26183	37.4041	1%, 0.2%
Hill Street	Blackwater Creek	0025BDWAY ST 0009LGHE RD	-79.18784	37.41218	1%, 0.2%
Hollins Mill Road	Blackwater Creek	.89 RT 501 / .84 RT 29 B	-79.15955	37.42533	1%, 0.2%
Hooper Road 662	Ivy Creek	0.40 Rt 1280; 0.70 Rt 621	-79.28248	37.39055	1%, 0.2%
Indian Hill Road	Ivy Creek	0.01-Indian H R-0.04-Gren	-79.20731	37.42672	1%, 0.2%
Lakeside Drive	Blackwater Creek	0019291 0084WCL LYNC	-79.18393	37.40163	0.2%
Langhorne Road	Ivy Creek	0.1-Crnhill Dr./0.1-Halsy	-79.18835	37.41675	No
Langhorne Road	Blackwater Creek	.0-Halsey/.14-Kulman	-79.18866	37.41574	No
Link Road	Ivy Creek	0104501 0104291	-79.20311	37.42707	1%, 0.2%
Mount Athos Road	Beaver Creek	0.05-Rt 609/2.03-ESMaint	-79.05978	37.39074	1%, 0.2%
Ninth Street	Kanawha	0003JEFF ST 0001DEAD END	-79.14003	37.41608	No
Old Forest Road	Blackwater Creek	0047221 0125LINKHYDR	-79.18791	37.40524	1%, 0.2%
River Road	Harris Creek	0.30-Rt 684/4.99-Rt 130	-79.15073	37.43892	1%, 0.2%
River Road	Buck Branch	.40-Rt 683/.10-Rt 684	-79.14648	37.43556	1%, 0.2%
Robin Drive	Tomahawk Creek	0.04 LCR - 0.56 OGMR	-79.23853	37.36427	1%, 0.2%
Route 29 Business	James R NS CSX R/R C Tpk	.00 Amherst / .00 Lynch.	-79.13471	37.40968	1%, 0.2%
Route 460 WBL	Beaver Creek	.40-Rt726 / 5.21-Rt24	-79.05461	37.38479	1%, 0.2%
Rt. 501	Ivy Creek	0112RTE221	-79.23184	37.41205	0.2%

Road Name	Crossing	Bridge / Tunnel Location	Lon	Lat	In flood zone
		0243RTE501BU			
Stage Road	Beaver Creek	0.10-Rt.726 /0.81-Rt.659	-79.05981	37.38895	No
AM&O - Jefferson Street Tunnel	-	Jefferson Street	-79.13979	37.41519	1%, 0.2%

Table 4-73 Vulnerable facilities and infrastructures in dam breach zone of Reusens Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Six Mile Bridge	Historic Site	Mount Athos Rd & James River	Campbell	-79.0612	37.3932	1%, 0.2%
Westrock Converting Company	HazMat Facility	1801 Concord Turnpike	Lynchburg	-79.1277	37.4032	1%, 0.2%
Lynchburg Foundry Co Lower Basin Plant	HazMat Facility	Garnet Street And Concord Turnpike	Lynchburg	-79.1318	37.4071	1%, 0.2%
Lynchburg Casting Industries	HazMat Facility	1132 Mt Athos Rd	Campbell	-79.0595	37.4027	0.2%
Reusens Dam Hydro Plant	Energy Facility	4300 Hydro Street	Lynchburg	-79.1867	37.4630	1%, 0.2%
Electrical Substation	Electrical Substation	127 Stonewall St	Lynchburg	-79.1447	37.4194	No
Electrical Substation	Electrical Substation	4370 Hydro St	Amherst	-79.1872	37.4622	1%, 0.2%
Amazement Square Child Museum	Attractions	27 9Th St	Lynchburg	-79.1403	37.4162	0.2%

4.4.3.2 Appomattox County and Town of Appomattox

According to DCR's DSIS inventory, there are 17 dams within Appomattox County and no dams in the Town of Appomattox. Of those dams, 11 are unknown/undetermined. There are no high hazard dams within the jurisdiction (Figure 4-62, Table 4-74).

The following issues have been identified for dam breach scenarios in Appomattox County:

- Caldwell Lake Dam (East Fork Falling River #15), a significant hazard dam, has had issues in the past, causing flooding.
- Potential bridge and culvert impacts

Table 4-74 Number of Dams in each Hazard Potential Category within Appomattox County, Virginia.

Hazard Potential	Number of Dams
HIGH	0
HIGH, SPECIAL	0
SIGNIFICANT	4
LOW	1
LOW, SPECIAL	1
UNKNOWN	11

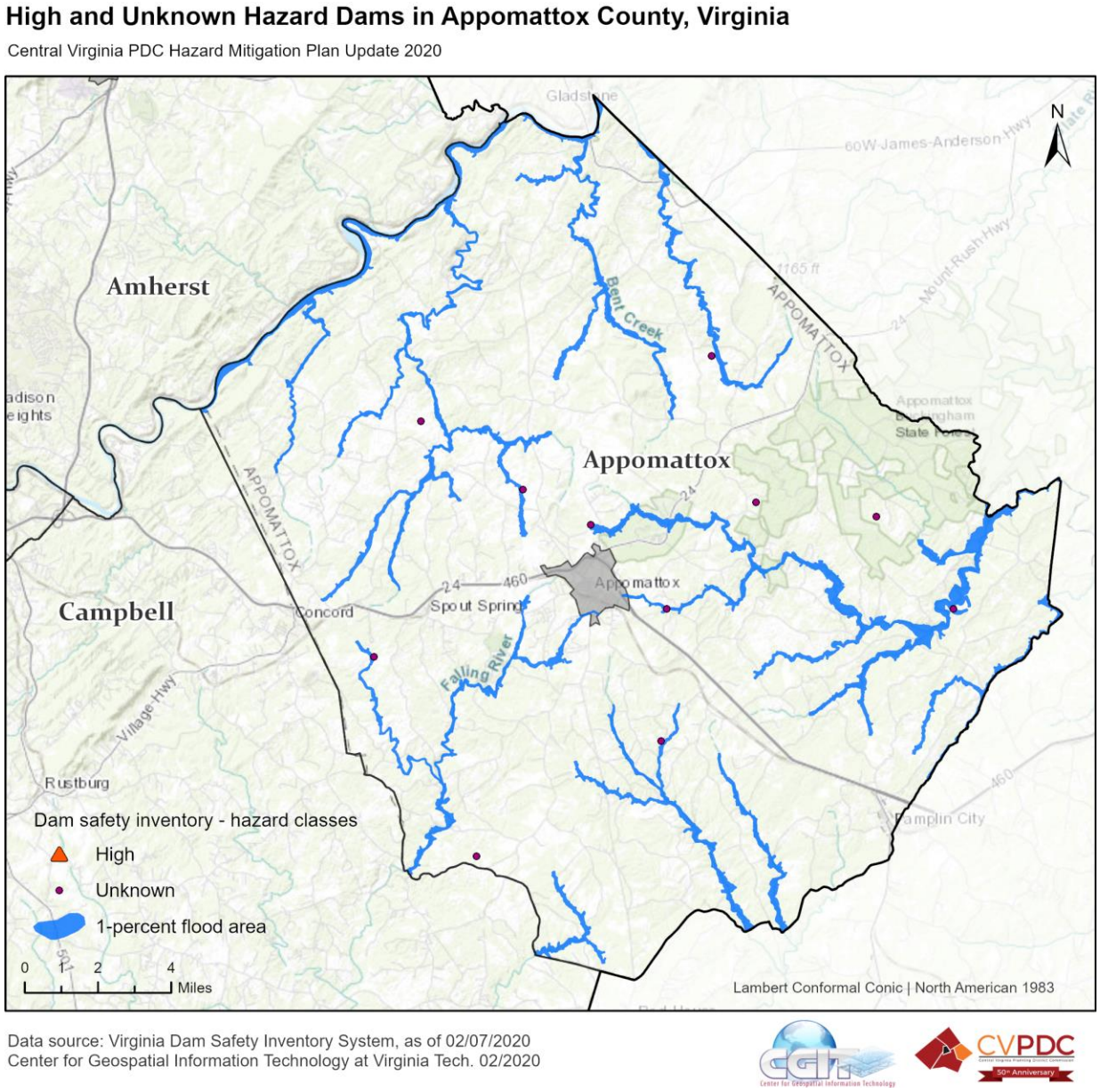


Figure 4-62 Location of High and Unknown hazard dams in Appomattox County, Virginia.

4.4.3.3 Bedford County and Town of Bedford

There are a total of 152 dams within Bedford County recorded in DCR's DSIS inventory and no dams within the Town of Bedford. Of the dams in Bedford County, 129 dams are of unknown/undetermined category and 12 (8%) dams are classified as high hazard potential (Figure 4-63, Table 4-75).

4.4.3.3.1 Principal Dam Breach Problems

The following issues have been identified for dam breach scenarios in Bedford County (also see Table 4-76):

- Electrical substation impacts
- Two pump stations and two water storage facilities
- CSX Railroad and Norfolk Southern Railroad impacts
- Big Island Highway (Route 122), Forest Road (Route 221), Lee Jackson Highway, Stewartsville Road (Route 24), and Jordantown Road impacts
- Several bridge and culvert impacts
- Several residences and businesses in the maximum inundation area
- Inundation areas not all readily available in a GIS format for high hazard dams

Table 4-75 Number of Dams in each Hazard Potential Category within Bedford County, Virginia.

Hazard Potential	Number of Dams
High	12
High, Special	0
Significant	4
Low	5
Low, Special	2
Unknown	129

Table 4-76 Critical facility and infrastructure in dam break inundation area within Bedford County

Facility Name	Facility Type	Address	Coordinates	Floodplain	Inundation Zone
Tri-County Marina	Campground	1261 Sunrise Loop, Lynch Station	37.0595, -79.4468	1%, 0.2%	Smith Mountain Dam
Tuck-A-Way Campground	Campground	1312 Sunrise Loop, Lynch Station	37.0605, -79.4484	No	Smith Mountain Dam
Electrical Substation	Electrical Substation	Big Island Hwy / North Otter Creek	37.4599, -79.4651	1%, 0.2%	Bedford Lake Dam
Smith Mountain Dam Hydro Plant	Energy Facility	Route 1, Penhook	37.0413, -79.5356	1%, 0.2%	Smith Mountain Dam
Coleman Falls Dam Hydro Plant	Energy Facility	6007 Lee Jackson Hwy, Coleman Falls	37.5021, -79.3006	1%, 0.2%	Pedlar River Dam
Holcomb Rock Dam Hydro Plant	Energy Facility	4839 Holcomb Rock Road	37.5036, -79.2628	1%, 0.2%	Pedlar River Dam
Mineral Springs Christian School	Schools	1030 Bible Ln, Vinton	37.2865, -79.8352	No	Falling Creek Reservoir Dam

Facility Name	Facility Type	Address	Coordinates	Floodplain	Inundation Zone
Pump Station #6	Sewer Pump Station	Peaks Rd / Woods Rd, Bedford	37.3894, -79.5516	1%, 0.2%	Stoney Creek Reservoir Dam
Lake Vista Pump Station	Sewer Pump Station	2474 Cottontown Rd, Forest	37.3953, -79.2606	1%, 0.2%	Ivy Lake Dam
Farmington Pump Station	Sewer Pump Station	1715 Helmsdale Dr, Forest	37.3845, -79.3008	No	Ivy Lake Dam
Water Pump Station - 5 (Town Of Bedford Water)	Water Booster Pump Station	4690 Peaks Rd, Bedford	37.3897, -79.5531	1%, 0.2%	Stoney Creek Reservoir Dam
Well Lot Ridgeview Sc 1	Water Storage Facility	Ridgeview Dr, Lynchburg	37.3976, -79.2588	No	Ivy Lake Dam

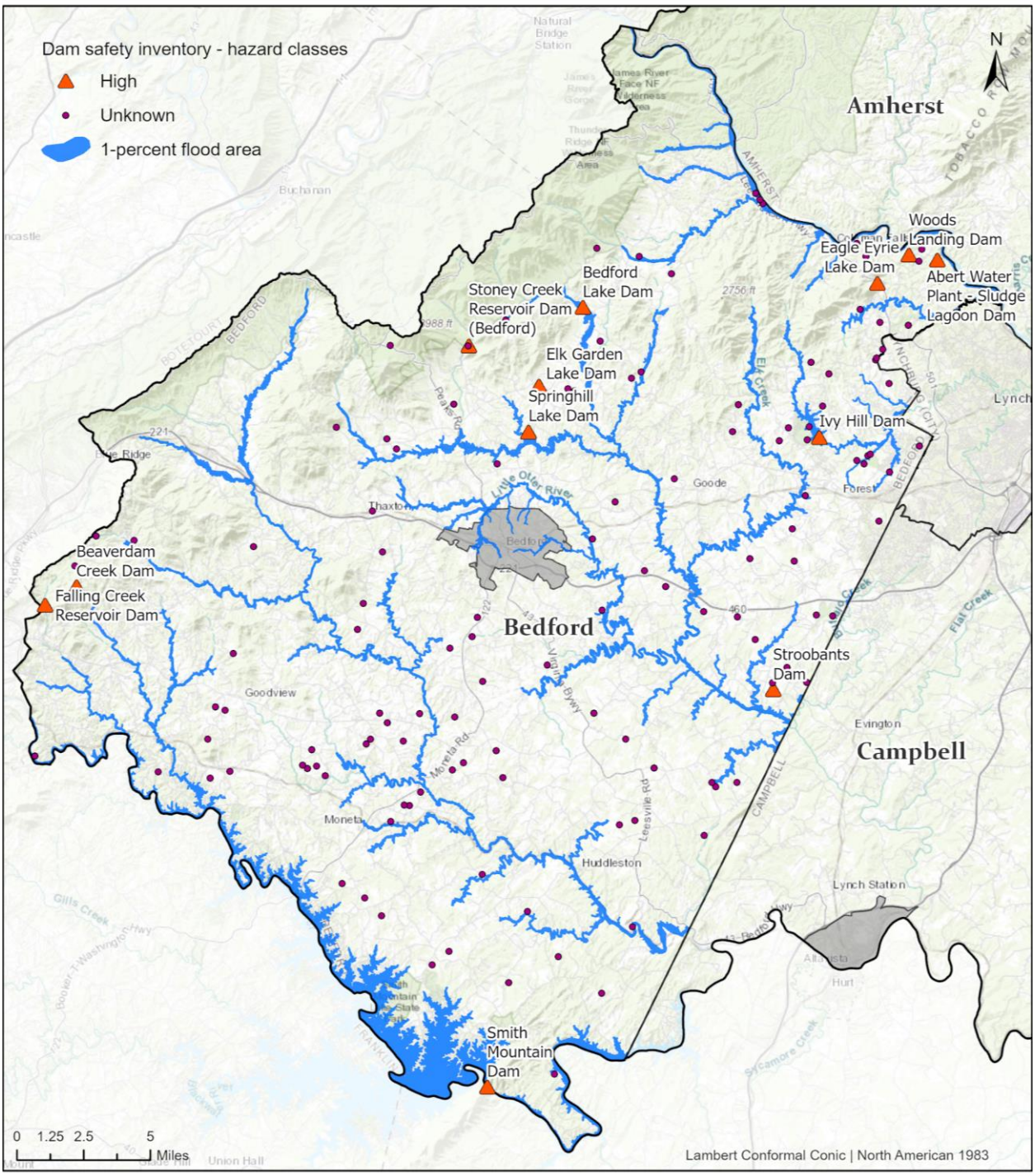


Figure 4-63 Location of High and Unknown hazard dams in Bedford County, Virginia.

4.4.3.3.2 Risk Analysis of Individual Dam

Abert Water Plant - Sludge Lagoon Dam

General information

The Abert Water Plant - Sludge Lagoon Dam was initially constructed in 1994. It is owned by the City of Lynchburg and is operated by the City's Water Resources Department. Because the lagoon is designed as a wastewater treatment facility, its perimeter is surrounded by channels designed to divert surface runoff. Wastewater normally flows through the lagoon and into the concrete outlet structure through an 8-inch diameter, gated orifice which is the primary spillway, and then into the 24-inch diameter outlet structure drain. In the event flow exceeds the primary spillway capacity, the grated open top of the outlet structure serves as the emergency spillway. The impoundment is capable of storing the 90% probable maximum precipitation (PMP) (with the emergency spillway completely obstructed) without overtopping the dam. The PMP is theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular geographical location at a certain time of the year. Flow from the spillway discharges to an unnamed tributary leading 2,000 feet to James River.

Dam break inundation zone

Figure 14 is an overview of the inundation zone map completed by Wiley &Wilson in January 2010 for the PMF of Abert Water Plant. The inundation zone is confined to property owned by the City of Lynchburg, except at the CSX Transportation right-of-way and railroad track along the river. The land is steep, densely wooded, undeveloped, and inaccessible by road. A PMF dam break would cause the James River water surface level to increase less than 1-foot. No action is required for properties affected by less than a 1-foot increase.

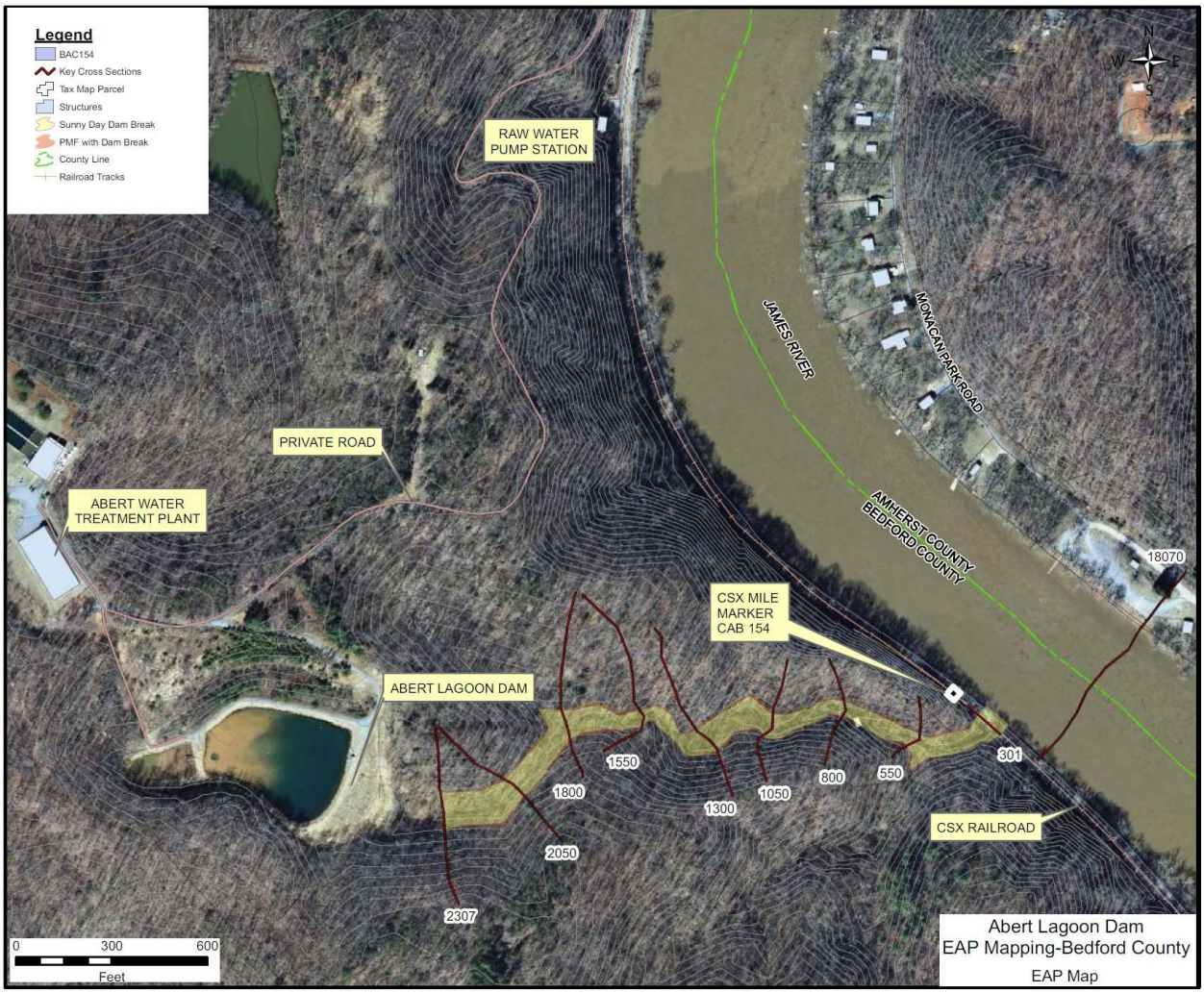


Figure 14. Inundation zone map of Abert Water Plant. (Source: Virginia DCR)

Vulnerable structures

According to the hazard classification study in the dam EAP, the CSX Railroad, which is considered a major railway, would be overtopped by a PMF breach. Dam break overtopping would be confined to a few hundred feet of railroad track and have a duration of 12 minutes. There are no habitable buildings, facilities, or road bridges within the inundation zone; therefore, notifying CSX Transportation is the highest priority in a dam breach event.

Beaverdam Creek Dam

General information

Beaverdam Creek Dam is located along Beaverdam Creek approximately 0.27 miles upstream of State Route 635 (Jeters Chapel Road) within Bedford County, Virginia. The Beaverdam Creek Reservoir was constructed in the 1920s and is maintained by the Western Virginia Water Authority, serving as one of three water supply reservoirs for the City of Roanoke, Virginia. The reservoir covers 21 acres and stores 85-million gallons of water at full pond.

Dam break inundation zone

The downstream area of the dam consists of low lying forested flood plain with sparse residential development. Figure 4-64 is an overview of the inundation zone map contained in the dam failure analysis of Beaverdam Creek Dam by Timmons Group in February 2011. According to Timmons Group's analysis, Beaverdam Creek Dam currently does not have the spillway capacity to convey a 0.9 PMP event and overtops by approximately 2.91 feet. The dam will require renovations in order to comply with state regulation requirements.

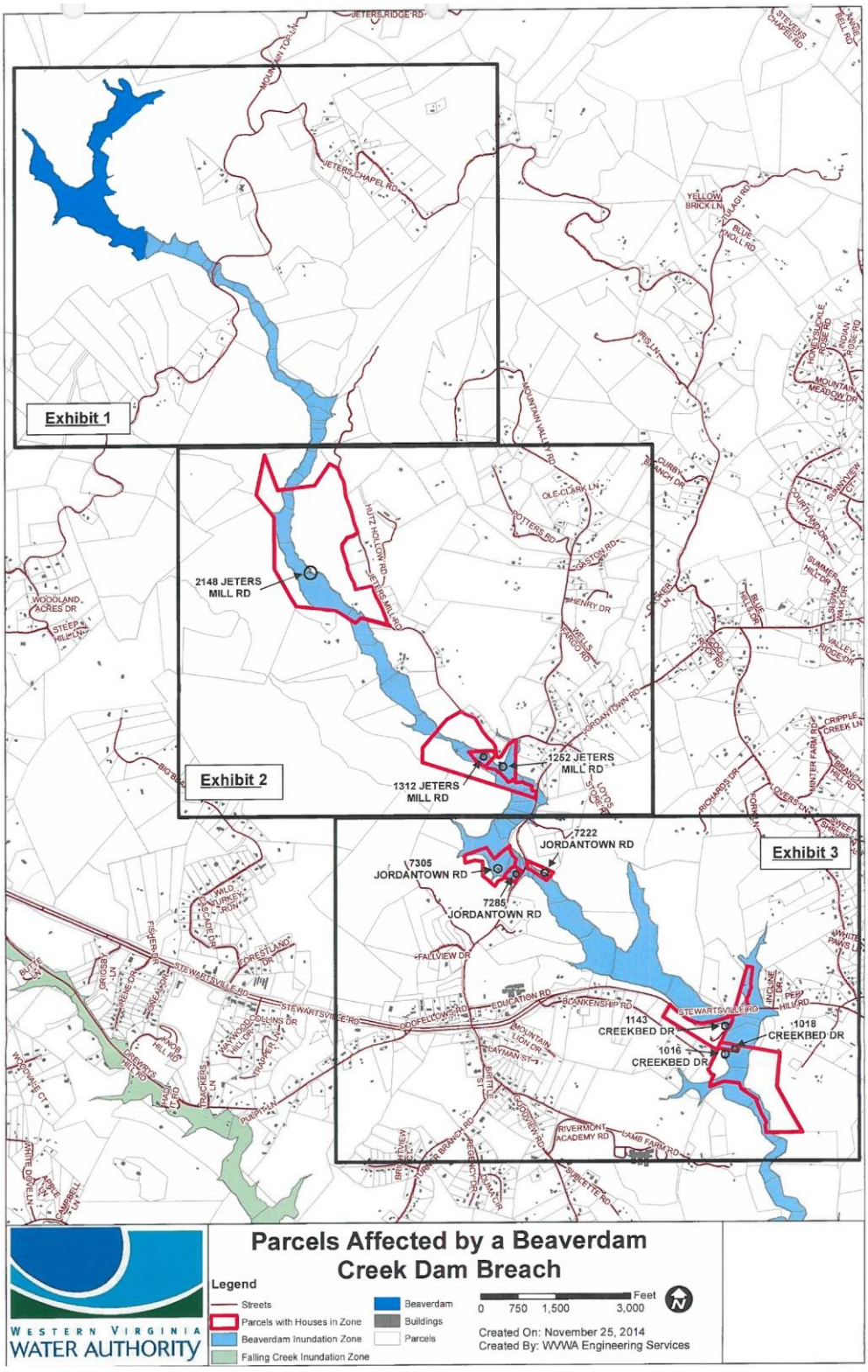


Figure 4-64 Inundation zone map of Beaverdam Creek Dam. (Source: Virginia DCR)

Vulnerable structures

As a result of a PMF breach, approximately 84 existing properties downstream of the Beaverdam Creek Dam would be inundated, resulting in a potential increased risk to life and property damage. Two major roads, including Stewartsville Road (Route 24) and Jordantown Road, may be flooded. Some road bridges may be impacted during a dam breach scenario (Table 4-77).

Table 4-77 Vulnerable road bridges in dam breach zone of Beaverdam Creek Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Jordantown Rd 619	Nat Branch	0.60-RT. 24;0.65-RT 759	-79.78881	37.27847	1%, 0.2%
Stewartsville Rd24	West Fork Beaverdam Creek	1.00 RT 619; 5.00 RT 746	-79.77452	37.27061	1%, 0.2%

Bedford Lake Dam

General information

Bedford Lake Dam is located approximately 0.5 miles northwest of Colton's Mill, Bedford County, Virginia, at the headwaters of North Otter Creek within the Roanoke River Basin. It was constructed in 1935 by the Civilian Conservation Corps for recreational purposes. The walkway across the spillway was replaced by the recent owners. It is an earthfill structure approximately 700 feet long and 52 feet high. The dam is a DCR regulated dam privately owned and maintained.

Dam break inundation zone

Figure 4-65 is an overview of the inundation zone map for the PMF of Bedford Lake Dam, completed by Froehling & Robertson, Inc. in September 2015.

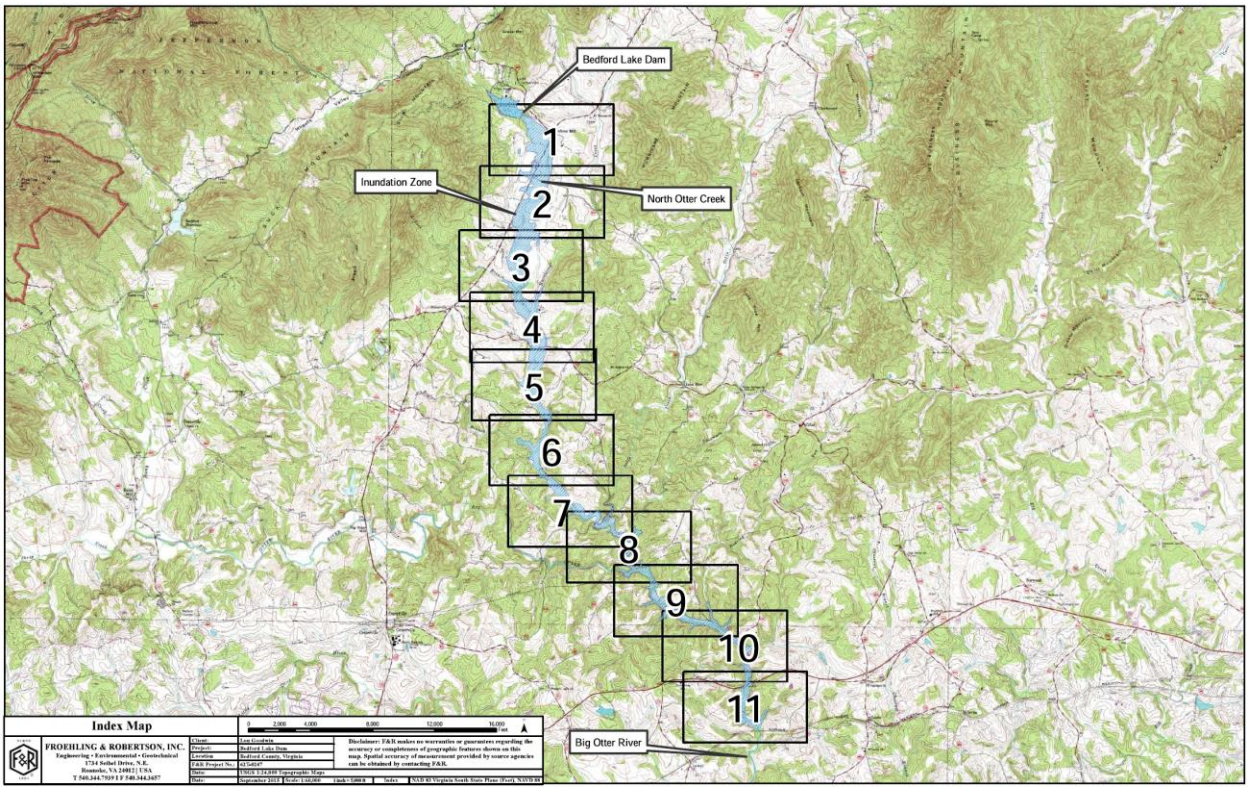


Figure 4-65 Inundation zone map of Bedford Lake Dam. (Source: Virginia DCR)

Vulnerable structures

Table 4-78 lists broad bridges within the dam break inundation zone. Part of Big Island Highway (Route 122), and Forest Road (Route 221) may be inundated during a dam breach event. There is one electrical substation identified in the inundation zone (Table 4-79).

Table 4-78 Vulnerable road bridges in dam breach zone of Bedford Lake Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Big Island Hwy 122	North Otter Creek	8.88 Rt 501; 8.50 Rt 221	-79.4648	37.46	1%, 0.2%
Forest Road 221	Big Otter River	0.16 Rt 830; 0.07 Rt 670	-79.4199	37.36447	1%, 0.2%
Hawkins Ridge Road	Roaring Run	2.10-RT 644 / 0.40-RT 670	-79.4267	37.37576	1%, 0.2%
Hurricane Dr 639	North Otter Creek	3.90 Rt 643; 0.17 Rt 122	-79.4648	37.45334	1%, 0.2%
Langford Mill644	North Otter Creek	0.60 Rt 675; 0.20 Rt 674	-79.4535	37.39239	1%, 0.2%
Lankford Mill 644	Oslin Creek	0.00 Rt 674; 0.80 Rt 637	-79.4506	37.39455	1%, 0.2%
Otterville Rd 643	N Fork Otter River	0.65 Rt 674; 1.51 Rt 122	-79.4664	37.42394	1%, 0.2%
Roaring Run Rd 670	Roaring Run	0.05 Rt 637; 0.45 Rt 221	-79.4198	37.37083	1%, 0.2%

Table 4-79 Vulnerable facilities and infrastructures in dam breach zone of Bedford Lake Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Electrical Substation	Electrical Substation	Big Island Hwy / North Otter Creek	Bedford	-79.4651	37.4599	1%, 0.2%

Eagle Eyrie Lake Dam

General information

Eagle Eyrie Dam is a 36.65 foot tall impounding structure used for supplying water to the Eagle Eyrie Baptist Conference Center. It is located on an unnamed section of Judith Creek in Bedford County, Virginia. From the dam, the tributary flows east approximately 8.9 miles before joining James River. The drainage area of the reservoir is 0.253 square miles.

Dam break inundation zone

Figure 17 is an overview of the inundation zone map for the PMF of Eagle Eyrie Lake Dam, completed by Hurt & Proffitt, Inc. in June 2019. The upstream inundation zone caused by the dam is defined as agricultural and residential, according to the land use map found on the Bedford County GIS website. The current level of development in the 0.253 square mile drainage area is low, consisting of a few residential homes along the east portions of the drainage area. There are a few structures in the downstream inundation zone.

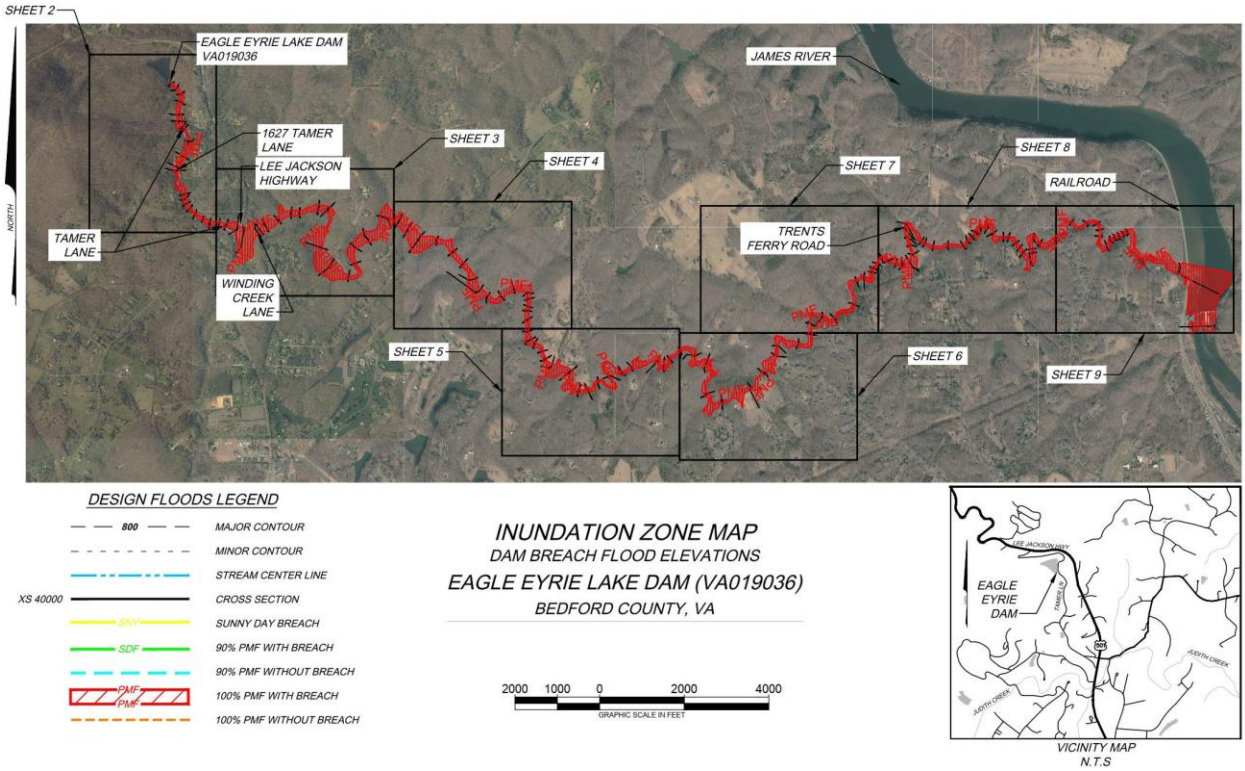


Figure 4-66 Inundation zone map of Eagle Eyrie Lake Dam. (Source: Virginia DCR)

Vulnerable structures

Within the inundation zone, there are several road bridges, roadways sections, and one residential home that may be inundated during a dam breach scenario. The roadways include one primary road (Lee Jackson Highway), three secondary roads (Tamer Lane, Winding Creek Lane, and Trents Ferry Road), and one private road (Gravel Road). The following road bridges may be impacted. (Table 4-80).

Table 4-80 Vulnerable road bridges in dam breach scenario of Eagle Eyrie Lake Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Lee-Jackson HWY501	Judith Creek @ Boonsboro	0.60 Rte 647;0.01 Rte 846	-79.2649	37.46554	1%, 0.2%
Trents Ferry R 645	Judith Creek	0.05-LYNCH CL;0.05-RT_794	-79.2101	37.46881	1%, 0.2%
Winding Crk La 647	Judith Creek	0.80 Rt 501; 0.00 Rt 761	-79.2628	37.46831	1%, 0.2%

Elk Garden Lake Dam

General information

Elk Garden Lake Dam is situated on a tributary of Boyles Branch, approximately 0.6 miles upstream of Big Island Highway (Route 122) in Bedford County, Virginia. It was constructed in 1959 for recreational purposes. The dam is 30 feet tall with a crest elevation of 896 feet and a normal pool elevation of 893 feet. The principal spillway is a 12-inch diameter reinforced concrete pipe conduit sloped at a shallow drop through the top of the embankment. The emergency spillway is located to the left end of the dam and is an uncontrolled earth channel with an entrance width of 40 feet. This spillway is reported to have a design capacity equal to a 100-Year Flood event.

Dam break inundation zone

Figure 4-67 indicates the dam break inundation zone for the PMF of Elk Garden Lake Dam. This map derives from the digitalization of the DBIZ maps provided in the EAP of the dam. The dam inundation studies were conducted by Froehling & Robertson, Inc. in October 2010.

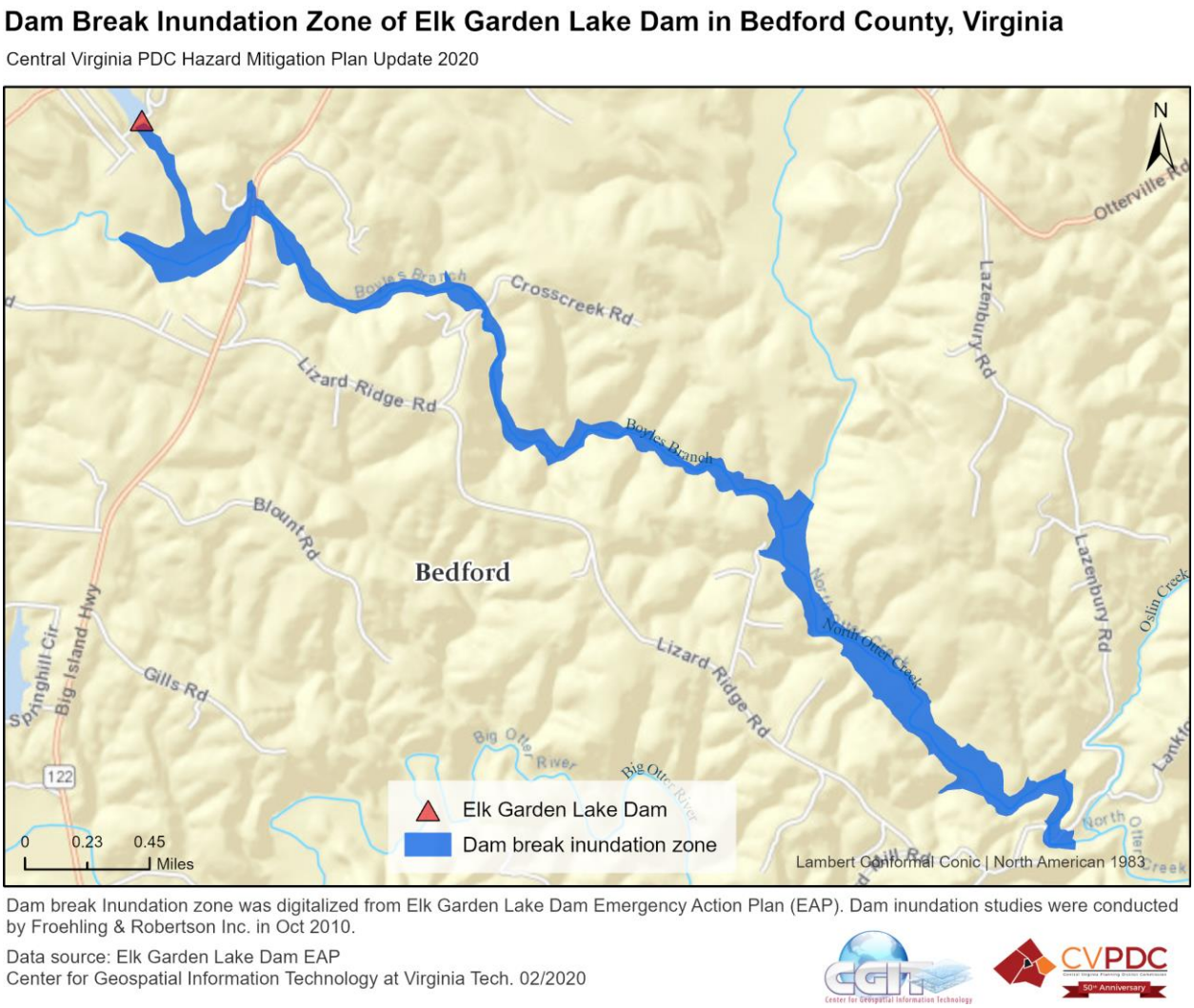


Figure 4-67 Inundation zone map of Elk Garden Lake Dam. (Source: Virginia DCR)

Vulnerable structures

Table 4-81 lists the VDOT road bridge that is within the inundation zone. Part of Big Island Highway (Route 122) and Crosscreek Road (Route 676) may be impacted during a dam breach event. There are also 23 downstream parcels that may be flooded.

Table 4-81 Vulnerable road bridges and tunnels in dam breach scenario of Elk Garden Lake Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Langford Mill644	North Otter Creek	0.60 Rt 675; 0.20 Rt 674	-79.45353	37.39239	1%, 0.2%

Falling Creek Reservoir Dam

General information

Falling Creek Dam is located in Bedford County, Virginia. The dam is 1.5 miles upstream from Virginia Route 24 on Falling Creek. The dam is used to impound water for use as a public water supply by the Western Virginia Water Authority. Falling Creek Dam is a 52 foot high earthen High Hazard Dam that was originally constructed in 1898, with major renovations in 2011. There is a water withdrawal tower in the reservoir that contains valves that control flows of raw water for water treatment or to drain. The principal spillway is a grouted riprap channel with drop gabions. The top and downstream face of the dam are armored with articulated concrete blocks designed to safely withstand overtopping flows, as the emergency spillway, up to the PMF event. Under flood conditions, operation by the principal spillway and emergency spillway (overtopping flow) is automatic and does not require any manual operation.

Dam break inundation zone

Figure 4-68 is an overview of the inundation zone map for the PMF of Falling Creek Reservoir Dam developed by AECOM Technical Services, Inc. in 2011.

The entire upstream drainage area is undeveloped mountainous forest. In the event of a dam failure, the potentially impacted areas downstream from the dam extend approximately 8.5 miles downstream to the confluence of Falling Creek with Smith Mountain Lake. This area contains mostly suburban and rural residential properties, with the densest development located near Virginia Route 24.

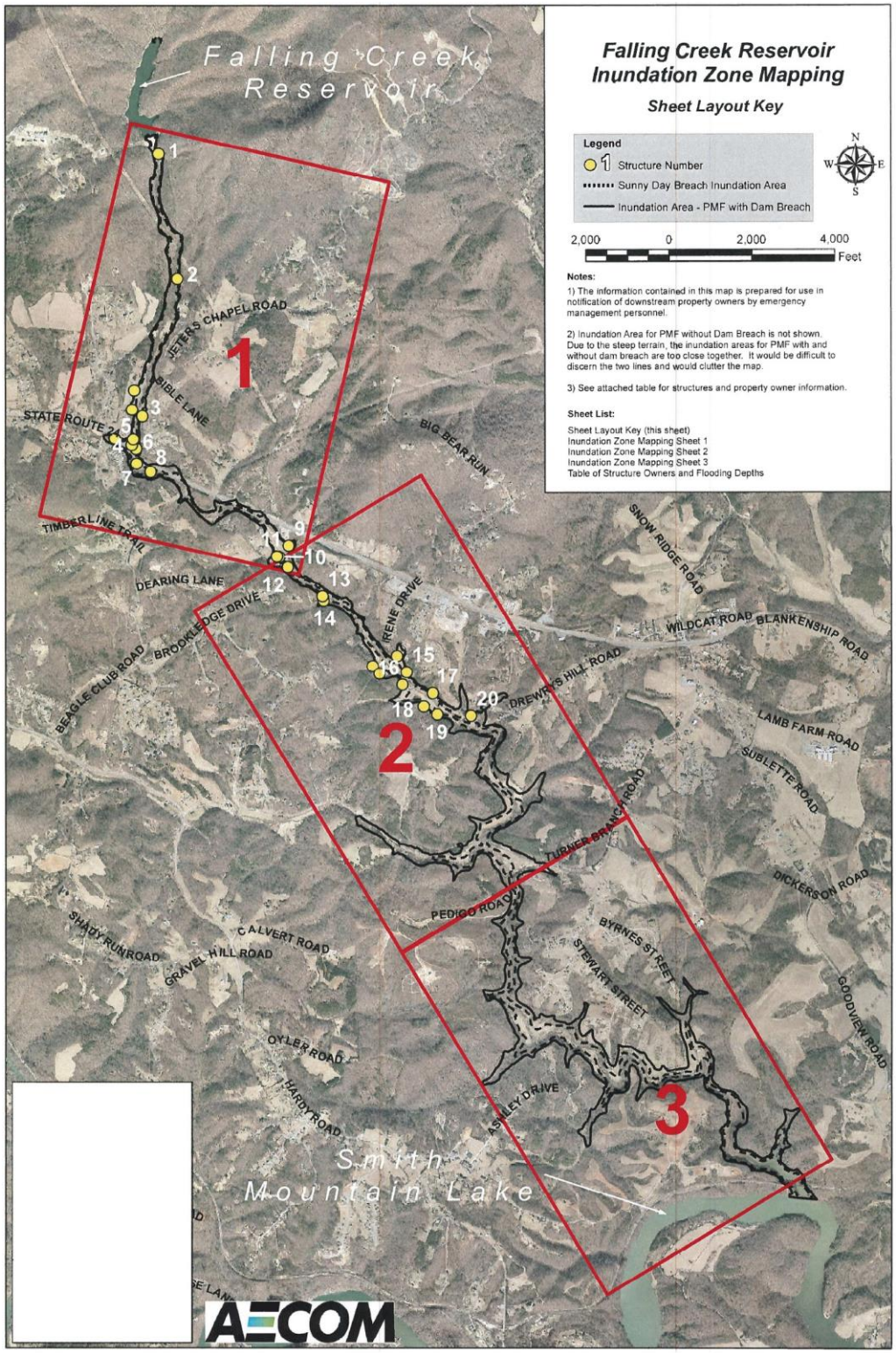


Figure 4-68 Inundation zone map of Falling Creek Reservoir Dam. (Source: Virginia DCR)

Vulnerable structures

During the dam breach event, several roads, structures, and one road bridge downstream of the dam may be impacted. Part of Stewartsville Road (Route 24) and Norfolk Southern Railroad tracks near the south bank of Smith Mountain Lake (79.7828°W 37.2343°N) may be flooded. Table 4-82 lists the VDOT road bridge that is within the inundation zone. 26 structures including residential buildings and barns also may be flooded. The parking lot of Mineral Springs Christian School at Bible Ln. is in the inundation area (Table 4-83).

Table 4-82 Vulnerable road bridges and tunnels in dam breach scenario of Falling Creek Reservoir Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Turner Branch Rd 619	Falling Creek	1.50 Rt 634; 1.50 Rt 757	-79.80906	37.25662	1%, 0.2%

Table 4-83 Vulnerable facilities and infrastructures in dam breach zone of Falling Creek Reservoir Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Mineral Springs Christian School	Schools	1030 Bible Ln	Bedford	-79.8352	37.2865	No

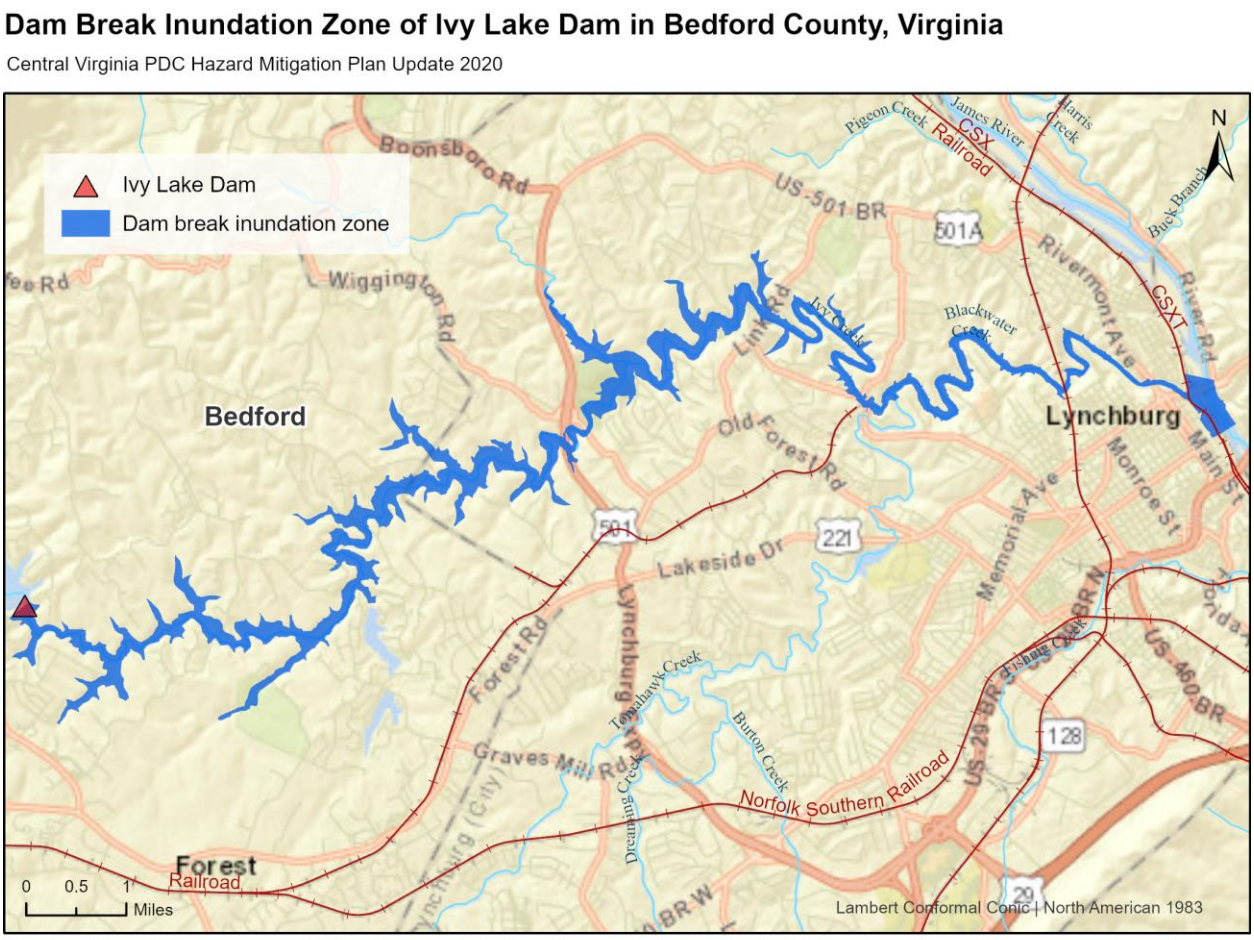
Ivy Lake Dam

General information

Ivy Lake Dam (or Ivy Hill Dam) is situated on Ivy Creek, approximately 2.5 miles northwest of Forest, in Bedford County, Virginia. It was constructed for recreational purposes. The dam is 66 feet tall, with a crest elevation of 833.0 feet and an emergency spillway elevation of 822.5 feet. The principal spillway is a 48-inch diameter reinforced concrete pipe conduit, which discharges near the toe of the embankment into a concrete stilling basin. The emergency spillway is located to the right end of the dam and is a broad crested earth spillway with an entrance width of 70 feet.

Dam break inundation zone

Figure 4-69 is an overview of the inundation zone map for the PMF of Ivy Lake Dam, digitized from the EAP of the dam.



Dam break Inundation zone was digitalized from Ivy Lake Dam Emergency Action Plan (EAP). Dam inundation studies were conducted by Froehling & Robertson Inc. in July 2018.

Data source: Elk Garden Lake Dam EAP; City of Lynchburg GIS Portal
Center for Geospatial Information Technology at Virginia Tech. 02/2020

Figure 4-69 Inundation zone map of Ivy Lake Dam. (Source: Virginia DCR)

Vulnerable structures

There are several roadways and bridges downstream within both Bedford County and Lynchburg City may be flooded if the Ivy Lake Dam should fail. Table 4-84 and Table 4-85 show those locations. AM&O - Jefferson Street Tunnel and U.S. Pipe in Lynchburg, as well as 2 water storage facilities and 2 sewer pump stations in Bedford, are also within the inundation zone (Table 4-86).

Table 4-84 Vulnerable roadways downstream of Ivy Lake Dam (Source: Ivy Lake Dam EAP)

Inundated Roadways	Distance From Dam (miles)	Jurisdiction
Ivy Wolf Lane	3.4	Bedford County
Ivy Lea Drive	4.4	Bedford County
Pine Bluff Drive (Rt. 1250)	5.4	Bedford County
Wigginton Road (Rt. 6004)	8.9	Bedford County
Peaks View Tenbury Drive	9.5	Lynchburg City

Inundated Roadways	Distance From Dam (miles)	Jurisdiction
Ardmore Drive	9.7	Lynchburg City
Dandridge Drive	9.8	Lynchburg City
Irvington Springs Road	9.9	Lynchburg City
Hurdle Hill Road	12.1	Lynchburg City
Club Drive	13.8	Lynchburg City
Old Langhorne Road	15.0	Lynchburg City
Halsey Road	15.1	Lynchburg City
Hill Street (Rt. 6082)	15.1	Lynchburg City
7th Street	20.1	Lynchburg City
Jefferson Street	20.2	Lynchburg City
10th Street	20.3	Lynchburg City
11th Street	20.4	Lynchburg City
Horse Ford Road	20.5	Lynchburg City
Washington Street (Rt. 6078)	20.6	Lynchburg City
E. Lynch Street	20.7	Lynchburg City

Table 4-85 Vulnerable road bridges and tunnels in dam breach scenario of Ivy Lake Dam

Road Name	Crossing	Bridge Location	Jurisdiction	Lon	Lat	In flood zone
Cottontown Rd./621	Ivy Creek	.40-RTE 1240;.25-RTE 884	Bedford County	-79.26179	37.39696	1%, 0.2%
Cranehill Drive	Ivy Creek	0.35LINKHORN/0.01LANGHORN	Lynchburg City	-79.19012	37.41823	No
Hawkins Mill Road	IVY CREEK	1.55-RTE 659;0.70-RTE 621	Bedford County	-79.26113	37.40342	1%, 0.2%
Hawkins Mill Rd 659	Howards Mill Creek	1.00 Lychbg; 0.50 Rt 660	Bedford County	-79.26183	37.40410	1%, 0.2%
Hollins Mill Road	Blackwater Creek	.89 RT 501 / .84 RT 29 B	Lynchburg City	-79.15955	37.42533	1%, 0.2%
Hooper Road 662	Ivy Creek	0.40 Rt 1280; 0.70 Rt 621	Bedford County	-79.28248	37.39055	1%, 0.2%
Indian Hill Road	Ivy Creek	0.01-Indian H R-0.04-Gren	Lynchburg City	-79.20731	37.42672	1%, 0.2%
Langhorne Road	Ivy Creek	0.1-Crnhill Dr./0.1-Halsy	Lynchburg City	-79.18835	37.41675	No
Link Road	Ivy Creek	0104501 0104291	Lynchburg City	-79.20311	37.42707	1%, 0.2%
Ninth Street	Kanawha	0003JEFF ST 0001DEAD END	Lynchburg City	-79.14003	37.41608	No
Rt. 501	Ivy Creek	0112RTE221 0243RTE501BU	Lynchburg City	-79.23184	37.41205	0.2%
AM&O - Jefferson Street Tunnel	7th Street	Jefferson Street	Lynchburg City	-79.13979	37.41519	0.2%

Table 4-86 Vulnerable facilities and infrastructures in dam breach zone of Ivy Lake Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Well Lot Ridgeview Sc 1	Water Storage Facility	Ridgeview Dr, Lynchburg	Bedford	-79.2588	37.3976	No
Lake Vista Pump Station	Sewer Pump Station	2474 Cottontown Rd, Forest	Bedford	-79.2606	37.3953	1%, 0.2%
Farmington Pump Station	Sewer Pump Station	1715 Helmsdale Dr, Forest	Bedford	-79.3008	37.3845	No
U.S. Pipe	HazMat Facility	10 Adams Street, Lynchburg	Lynchburg	-79.1413	37.4208	1%, 0.2%

Smith Mountain Dam

General information

Smith Mountain Dam was built on Roanoke River by the Appalachian Power Company in the mid-1960s for the purposes of pumped-storage hydroelectricity. It is located near Roanoke, Virginia, upstream of the Leesville Dam. The two dams and reservoirs -- Smith Mountain and Leesville -- have added about 600 miles of new shoreline and about 25,000 surface acres of water for multiple uses. The dam is an Exempt Federal dam.

Dam break inundation zone

Upstream of the Smith Mountain Dam, the drainage basin is typically rural with limited agriculture and extensive wooded area. The nearest metropolitan area, the City of Roanoke, is located approximately 45 miles upstream of the dam. There are no dams located upstream of the project that contain an appreciable amount of storage space where project inflow could be stored.

Along Roanoke River (locally known as Staunton River) downstream of the Leesville Dam, agricultural activities become more pronounced. Downstream of Leesville, the nearest population center is the Town of Altavista, which is located 10 miles downstream of the dam. Due to the close proximity to the dam, the Town of Altavista is notified first in the event of an emergency. The closest downstream dam is the Corps of Engineer's John H. Kerr Reservoir, which is located approximately 150 miles below Leesville Dam. Passage of the floods generated by dam failures at either the Smith Mountain Dam or Leesville Dam is highly dependent on the operation of the Kerr Dam, as well as flooding conditions along Dan River, which flows into Kerr Reservoir.

Figure 4-70 is an overview of the inundation zone for the PMF of Smith Mountain Dam developed by the Appalachian Power Company in July 2015.

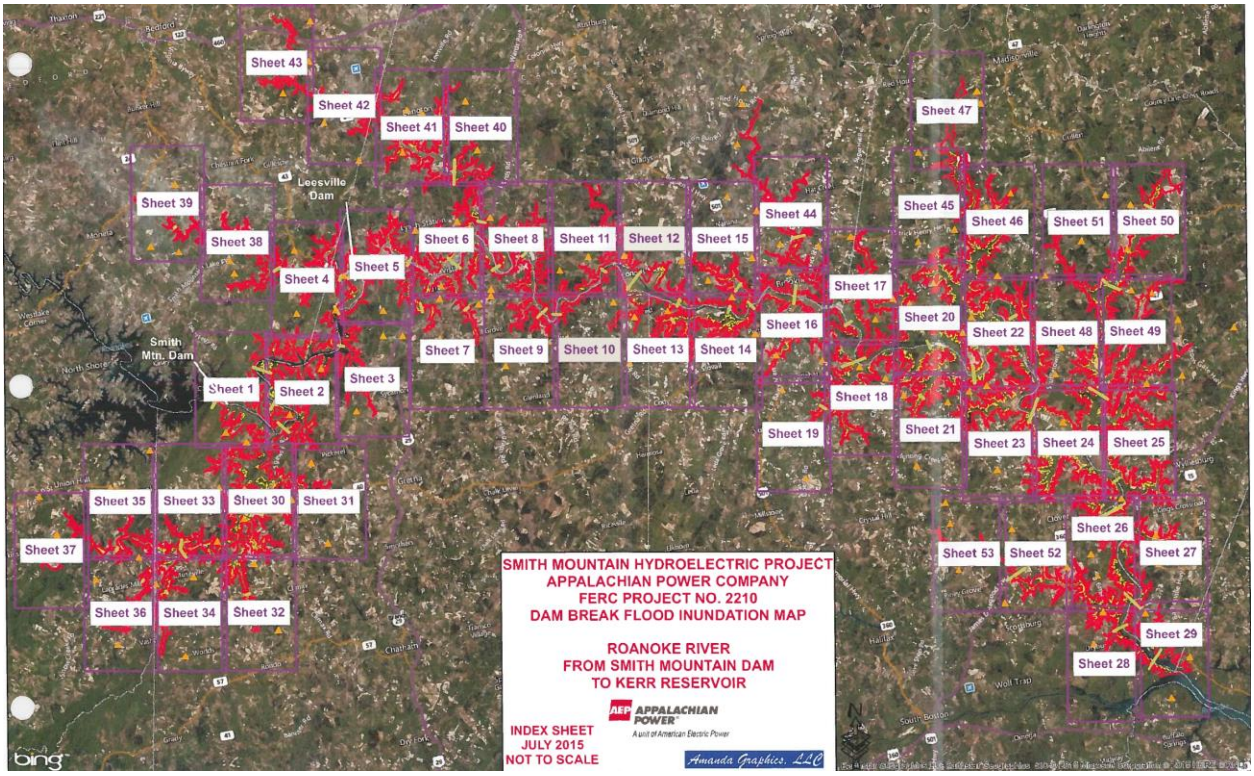


Figure 4-70 Inundation zone map of Smith Mountain Dam. (Source: Virginia DCR)

Vulnerable structures

Many roadways, road bridges, and critical facilities downstream within Bedford County Campbell County, Town of Altavista and Town of Brookneal may be flooded if the Smith Mountain Dam should fail. Table 4-87 and Table 4-88 show locations of those structures.

The following major roads and railways may be impacted: Main Street, Bedford Avenue (Route 43) and Wards Road (Route 29) in Town of Altavista, Wickliffe Avenue and Lusardi Drive in Town of Brookneal, Bedford Highway, and N&S Railroad tracks along Roanoke River.

There are many critical facilities and vulnerable infrastructures downstream of Smith Mountain Dam. Most of them are located within the Town of Altavista and the Town of Brookneal. See Table 4-88.

Table 4-87 Vulnerable road bridges in dam breach scenario of Smith Mountain Dam

Road Name	Crossing	Bridge Location	Jurisdiction	Lon	Lat	In flood zone
AYERS RD. 737	NS RAILWAY	0.20-RT 732;1.90-RT 805	Bedford County	-79.52055	37.17055	No
Bishops Cr. Rd.628	Back Creek	0.50 Rt 629; 0.15 Camp C	Bedford County	-79.38482	37.15424	No
CARTERS MILL RD630	ASHWELL MILL CREEK	2.55-RT 626;3.35-RT 733	Bedford County	-79.46834	37.12462	1%, 0.2%
Dundee Road/	Clover Creek	1.15 Rte732; 1.65	Bedford	-79.50105	37.12572	1%, 0.2%

Road Name	Crossing	Bridge Location	Jurisdiction	Lon	Lat	In flood zone
734		Rte626	County			
Headens Br Rd 732	Goose Creek	0.10 Rt 735; 0.00 Rt 737	Bedford County	-79.51821	37.16838	1%, 0.2%
Leesville Rd 43	Back Creek	0.15 Cpbl Co; 2.45 Rt 728	Bedford County	-79.40075	37.12856	1%, 0.2%
Rock Cliff Rd 735	Difficult Creek	3.20 Rt 731; 0.10 Rt 817	Bedford County	-79.52491	37.17852	No
SMTH MT LKE PKW626	GOOSE CREEK_& NS RWY	0.25-RT 833;1.75-RT 630	Bedford County	-79.47584	37.1568	1%, 0.2%
Tolers Ferry R 608	Howells Creek	3.65 RT 872; 4.00 Pitt Co	Bedford County	-79.49003	37.04812	No
Wyatts Way 24	Big Otter River	0.01 Rt 709; 0.90 Rt 792	Bedford County	-79.34963	37.24541	1%, 0.2%
Wyatts Way/24	Br. of Big Otter River	1.79-Camb Co;0.19-Rt 709	Bedford County	-79.34501	37.24559	1%, 0.2%
WYATTS WAY/24	BUFFALO CREEK	0.11 CAMP CO; 7.54 RT 43E	Bedford County	-79.32418	37.25219	1%, 0.2%
Bedford Highway	Bishop Creek	1.05-Rt 896/3.20-Rt 682	Campbell County	-79.33889	37.13855	1%, 0.2%
Bedford Highway	Plumtree Branch	6.03 Alvsta/1.67 Bed CL	Campbell County	-79.37908	37.12134	1%, 0.2%
Bishop Creek Road	Bishop Creek	1.10-Rt.43/2.07-Rt.682	Campbell County	-79.33162	37.14621	1%, 0.2%
Chellis Ford Road	Goose Creek	0.20-Rt. 43/0.10-Rt 718	Campbell County	-79.38721	37.11659	1%, 0.2%
Covered Bridge Rd	Seneca Creek	1.60-Rt 761/0.60-Rt 633	Campbell County	-79.11541	37.11749	1%, 0.2%
Covered Bridge Rd	Swan Creek	.74-Rt.824/.69-Rt.821	Campbell County	-79.1525	37.09167	No
Dearborn Road	Flat Creek	0.55-Rt.694/1.26-Rt.709	Campbell County	-79.2643	37.21163	1%, 0.2%
Dearborn Road	Branch Troublesome Creek	0.27-Rt.693/0.24-Rt.914	Campbell County	-79.23632	37.19945	0.2%
Dearborn Road	Troublesome Creek	0.10-Rt 693/0.60-Rt 709	Campbell County	-79.23827	37.20486	1%, 0.2%
Epsons Road	Whipping Creek	0.30-Rt 614/1.30-Rt 613	Campbell County	-79.0065	37.0608	1%, 0.2%
Evington Road	Buffalo Creek	0.60-Rt 934/2.10-Bedfo CL	Campbell County	-79.30521	37.24731	1%, 0.2%
Gladys Road	Seneca Creek	0.12-Rt.629 / 1.80-Rt.697	Campbell County	-79.13196	37.13937	1%, 0.2%
Gladys Road	Hills Creek	0.50-Rt.1340/0.90-	Campbell	-79.20318	37.12711	No

Road Name	Crossing	Bridge Location	Jurisdiction	Lon	Lat	In flood zone
		Rt.706	County			
Goat Island Road	Seneca Creek	0.20-Rt 700 / 0.70-Rt.703	Campbell County	-79.12268	37.10694	1%, 0.2%
Irvindale Road	Little Falling River	0.60-Rt 645 / 1.00-Rt 601	Campbell County	-78.91443	37.13079	1%, 0.2%
Lambs Church Road	Hills Creek	1.45-Rt 696 / 3.15-Rt 699	Campbell County	-79.18883	37.13892	No
Leesville Road	Otter River	0.24-Rt.626/0.85-Rt.694	Campbell County	-79.30358	37.20857	1%, 0.2%
Leesville Road	NS Railway	0.72 Rt 694/0.53 Rt 24	Campbell County	-79.28608	37.22592	No
Leesville Road	Johnson Creek	.05-Rt.626S / .05-Rt.626N	Campbell County	-79.30724	37.20628	1%, 0.2%
Lewis Ford Rd	Falling River	0.6-Rt. 641/1.2-Rt. 642	Campbell County	-78.9599	37.12661	1%, 0.2%
McIver Ferry Rd	Branch Whipping Creek	0.17-Rt. 633/2.61-Rt. 635	Campbell County	-79.00734	37.05542	1%, 0.2%
Route 24	Flat Creek	1.45-Rt.692 / 0.95-Rt.696	Campbell County	-79.26191	37.23297	1%, 0.2%
Route 29 NBL	Big Otter River	8.89-Rt 24/.28-Rt 29BUS	Campbell County	-79.24363	37.13981	1%, 0.2%
Route 29 SBL	Otter River	8.89-Rt 24/.28-Rt 29 Bus	Campbell County	-79.24336	37.13992	1%, 0.2%
Route 43	Route 29 Bypass	0.02-Alta CL/7.67-Bed CL	Campbell County	-79.30697	37.12769	No
Route 714	Route 29 Bypass	.95-Rt 712/.10-Alta. CL	Campbell County	-79.25015	37.13795	No
Rt 29 Bypass SBL	NS Railway & Route 626	2.94-Rt 29 B/0.54-Rt 43	Campbell County	-79.29845	37.13222	No
Seneca Road	Seneca Creek	0.17-Rt 703/0.03-Dead End	Campbell County	-79.12515	37.09177	1%, 0.2%
Seneca Road	Seneca Creek	0.10- Rt 703/0.80-Rt 705	Campbell County	-79.12751	37.09434	1%, 0.2%
Swinging Bridge Rd	Falling River	1.00-Rt 601W/.20-Rt 601E	Campbell County	-78.93592	37.08383	1%, 0.2%
Three Creeks Road	Suck Creek	1.04-Rt 708/2.19-Rt 942	Campbell County	-78.98693	37.14848	No
Three Creeks Road	Mollys Creek	0.90-Rt.652/0.60-Rt.708	Campbell County	-78.97235	37.17059	1%, 0.2%
Clarion Road	Rt 29 Bypass NBL & SBL	0.40-Rt 712/0.00-Alta CL	Town of Altavista	-79.26851	37.13884	No
Clarion Road	Stream	0.09-Rt.714/1.10-Rt.712	Town of Altavista	-79.27431	37.1294	1%, 0.2%
Riverbend Road	Otter River	0.05-Rt 875/0.20-Rt	Town of	-79.24405	37.13881	1%, 0.2%

Road Name	Crossing	Bridge Location	Jurisdiction	Lon	Lat	In flood zone
		29B	Altavista			
Route 29 Bus.	Staunton River & NS Rwy	0.00-CmpbCo./0.00-PittCo.	Town of Altavista	-79.27074	37.12679	1%, 0.2%
Dog Creek Road	Dog Creek	0.40-Rt 40 / 1.15-Rt 881	Town of Brookneal	-78.92594	37.04921	1%, 0.2%
Wickliffe Avenue	Falling River	.06-E Brknl / 4.20-Cha Co	Town of Brookneal	-78.93579	37.0536	1%, 0.2%

Table 4-88 Vulnerable facilities and infrastructures in dam breach zone of Smith Mountain Dam

Name	Facility Type	Location	Jurisdiction	Lon	Lat	In flood zone
Avoca Museum	Attractions	1514 Main St, Altavista, Va 24517	Town of Altavista	-79.2697	37.1300	No
The Mansion	Historic Site	1580 Mansion Bridge Rd, Altavista	Town of Altavista	-79.2399	37.1246	No
Lane Home Furnishings	HazMat Facility	701 5Th St, Altavista	Town of Altavista	-79.2855	37.1097	1%, 0.2%
Abbott Laboratories - Ross Products Division	HazMat Facility	1516 Main St, Altavista	Town of Altavista	-79.2658	37.1333	No
Bgf Industries	HazMat Facility	401 Amherst Avenue, Altavista	Town of Altavista	-79.2782	37.1122	1%, 0.2%
Dominion - Altavista Power Station	HazMat Facility	104 Wood Lane	Town of Altavista	-79.2734	37.1187	No
Altavista Fire Company	Fire Stations	1280 Main Street, Altavista	Town of Altavista	-79.2755	37.1199	No
Altavista Police Department	Law Enforcement	510 7Th Street, Altavista	Town of Altavista	-79.2899	37.1103	No
Altavista Power Station	Energy Facility	104 Wood Lane, Altavista	Town of Altavista	-79.2735	37.1188	No
Altavista Wastewater Plant	Wastewater Treatment Plant	Ln Access Rd, Altavista	Town of Altavista	-79.2740	37.1123	1%, 0.2%
Altavista Area YMCA Family Center	Large Population Venue	1000 Franklin Ave, Altavista, Va 24517	Town of Altavista	-79.2889	37.1140	1%, 0.2%
WODI - AM - The Rain Broadcasting, Inc.	Communicatio n Facility	1230 Radio Road Brookneal, VA 24528	Town of Brookneal	-78.9420	37.0384	1%, 0.2%
Cat Rock Sluice	Historic Site	General Location	Town of	-78.9599	37.0436	1%,

Name	Facility Type	Location	Jurisdiction	Lon	Lat	In flood zone
			Brookneal			0.2%
Red Hill	Historic Site	1430 Red Hill Rd	Town of Brookneal	-78.8980	37.0322	No
Brookneal Town - Falling River	Wastewater Treatment Plant	Wickliffe Ave, Brookneal	Town of Brookneal	-78.9340	37.0522	1%, 0.2%
Brookneal Town - Staunton River	Wastewater Treatment Plant	Radio Rd, Brookneal	Town of Brookneal	-78.9391	37.0376	1%, 0.2%
Green Hill	Historic Site	378 Pannills Rd, Gladys	Campbell	-79.0722	37.0621	No
Leesville Hydro Plant	Energy Facility	Rt. 754, Hurt	Campbell	-79.4022	37.0931	1%, 0.2%
Altavista Water Treatment Plant	Wastewater Treatment Plant	20 Ricky Van Shelton Dr, Hurt, Va 24563	Campbell	-79.2833	37.1045	No
Tri-County Marina	Campground	1261 Sunrise Loop, Lynch Station	Bedford	-79.4468	37.0595	1%, 0.2%
Tuck-A-Way Campground	Campground	1312 Sunrise Loop, Lynch Station	Bedford	-79.4484	37.0605	No
Smith Mountain Dam Hydro Plant	Energy Facility	Route 1, Penhook	Bedford	-79.5356	37.0413	1%, 0.2%

Spring Hill Lake Dam

General information

Spring Hill Lake Dam (*aka* Spring Hill Estates Dam or Toms Dam) is situated on a tributary of Big Otter River, approximately 0.32 river miles upstream of it's convergence with Big Otter River in Bedford County, Virginia. The dam impounds Spring Hill Lake, an approximate 13.9 acre reservoir at normal pool. The drainage area to the Spring Hill Estates Dam was calculated to be 0.181 square miles (115.8 acres). Spring Hill Estates Dam was constructed as a recreational impoundment. The dam is 44 feet tall with a crest elevation of 829 feet and a normal pool elevation of 824 feet. This dam is unattended during normal operating conditions.

Dam break inundation zone

Figure 4-71 is an overview of the inundation zone map for the PMF of Spring Hill Lake Dam, completed by Froehling & Robertson, Inc. in March 2017.

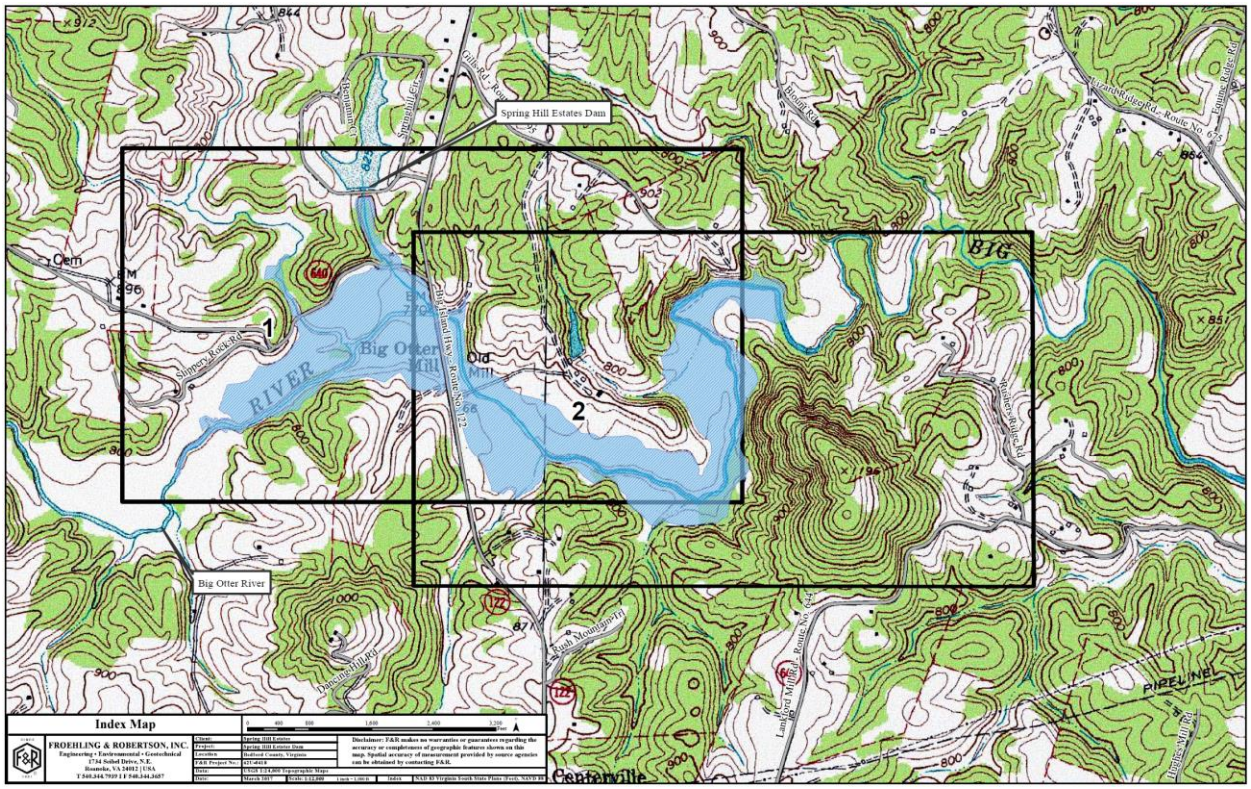


Figure 4-71 Inundation zone map of Spring Hill Lake Dam. (Source: Virginia DCR)

Vulnerable structures

Part of Big Island Highway (Route 122) and two VDOT road bridges may be impacted within Bedford County during a dam breach event (see Table 4-89). There is also one residential structure that would be endangered should the impounding structure fail. There are no other critical facilities identified in the inundation zone.

Table 4-89 Vulnerable road bridges in dam breach scenario of Spring Hill Lake Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Big Island Hwy/122	Big Otter River	00.10 RT 640;02.68 NCL BD	-79.50464	37.39275	1%, 0.2%
Forbes Mill Rd 640	Br. of Big Otter River	0.40 Rt 122; 1.00 Rt 682	-79.51079	37.39288	1%, 0.2%

Stoney Creek Reservoir Dam (Bedford)

General information

Stoney Creek Reservoir Dam (*aka* Bedford Reservoir Dam) is situated on Stoney Creek, about 7.7 miles from the Town of Bedford, in Bedford County, Virginia. The dam is used to impound water for public water supply

and operated by the Town of Bedford. It was built in 1954 and repaired in 2012. The drainage area to the reservoir is approximately 6.2 square miles.

Dam break inundation zone

Figure 23 is an overview of the inundation zone map for the PMF of Stoney Creek Reservoir Dam, completed by Schnabel Engineering in December 2012.

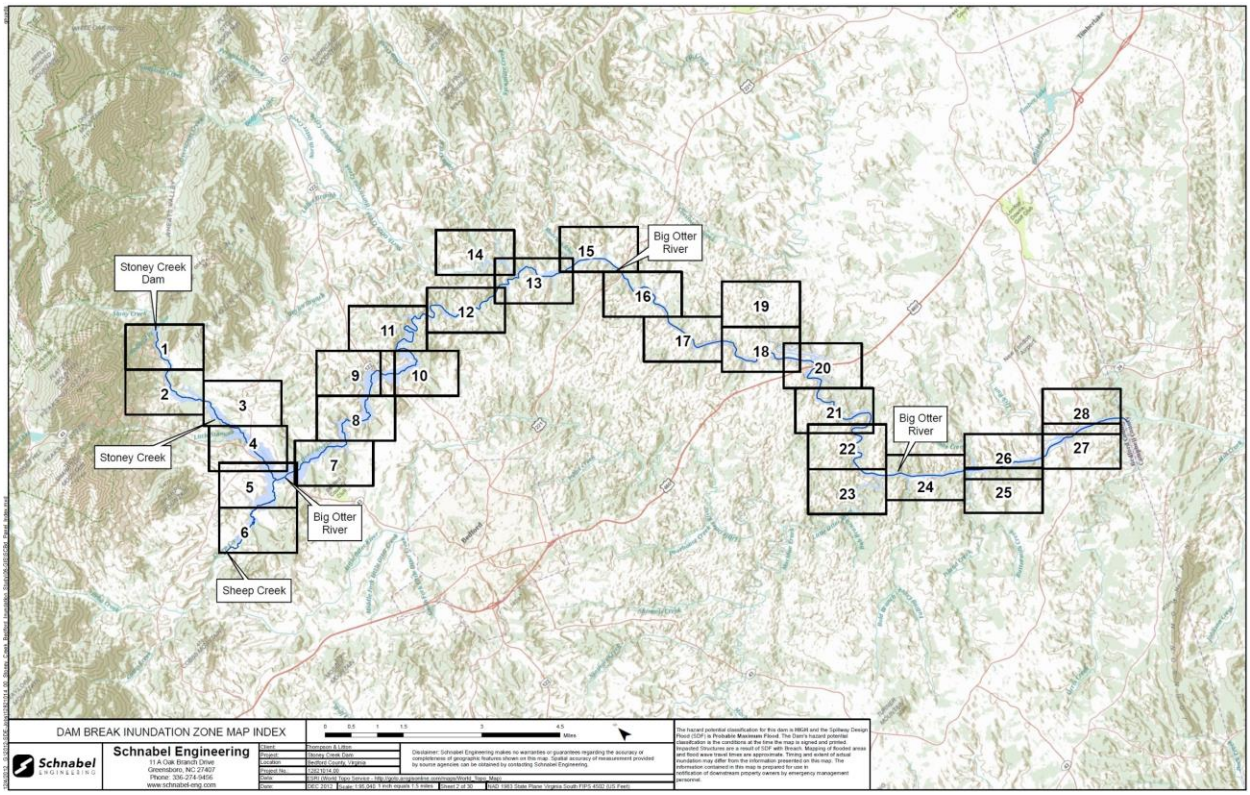


Figure 4-72 Inundation zone map of Stoney Creek Reservoir Dam. (Source: Virginia DCR)

Vulnerable structures

There are several roadways and bridges downstream within both Bedford County may be flooded if the Stoney Creek Reservoir Dam should fail. Table 4-90 and Table 4-91 show those locations. A sewer and one water booster pump station were identified in the inundation zone (Table 4-92).

Table 4-90 Vulnerable roadways downstream of Stoney Creek Reservoir Dam

Inundated Roadways	Distance From Dam (miles)	Jurisdiction
Rt. 640/Wheats Valley Road	0.5	Bedford County
Stonesbrook Farms Road	1	Bedford County
Rt. 850/Meadors Mill Road	2	Bedford County
Rt. 643/Jopling Road	3.4	Bedford County
Rt. 43/Peaks Road	4.2	Bedford County
Rt. 43/Peaks Road	4.6	Bedford County
Rt. 122/Big Island Hwy	8.1	Bedford County

Inundated Roadways	Distance From Dam (miles)	Jurisdiction
Rt. 644/Lankford Mill Road	12.7	Bedford County
US 221/Forest Road	16.4	Bedford County
US 460/East Lynchburg Salem Turnpike	21.6	Bedford County
Rt. 24/Wyatts Way	30.2	Bedford County
Railroad Near Della Wood Lane	17.2	Bedford County

Table 4-91 Vulnerable road bridges in dam breach scenario of Stoney Creek Reservoir Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
460 EBL	Big Otter River	6.34 Bedfd; 5.94 Camp Co	-79.39473	37.30892	1%, 0.2%
Big Island Hwy/122	Big Otter River	00.10 RT 640;02.68 NCL BD	-79.50464	37.39275	1%, 0.2%
E.Ly.Sa.Tk 460 WBL	BIG OTTER RIVER	5.94 CMBL CO; 6.34 Bedfd	-79.39396	37.30847	1%, 0.2%
Forbes Mill Rd 640	Br. of Big Otter River	0.40 Rt 122; 1.00 Rt 682	-79.51079	37.39288	1%, 0.2%
Forest Road 221	Big Otter River	0.16 Rt 830; 0.07 Rt 670	-79.41991	37.36447	1%, 0.2%
Gilly/Bush/Rd.R706	Elk Creek	0.20 Rt 460; 2.32 Rt 668	-79.39337	37.31040	1%, 0.2%
Hawkins Ridge Road	Roaring Run	2.10-RT 644 / 0.40-RT 670	-79.42671	37.37576	1%, 0.2%
Jopling Road 643	Stony Creek	0.40 Rt 640; 0.10 Rt 43	-79.55390	37.40374	No
Langford Mill644	North Otter Creek	0.60 Rt 675; 0.20 Rt 674	-79.45353	37.39239	1%, 0.2%
Lankford Ml RD/644	Big Otter River	0.01-RT 673; 0.50-RT 675	-79.46536	37.38664	1%, 0.2%
Meadows Mill R 850	Stony Creek	0.00 D END; 0.30 Rt 640	-79.55508	37.42156	No
Peaks Road / 43	Stony Creek	0.30-RT.682S;0.27-RT.682N	-79.55515	37.39276	1%, 0.2%
Peaks Road /43	Big Otter River	2.69 Bdfd; 0.00 Rte. 682S	-79.55122	37.38959	1%, 0.2%
Roaring Run Rd 670	Roaring Run	0.05 Rt 637; 0.45 Rt 221	-79.41984	37.37083	1%, 0.2%
Wyatts Way 24	Big Otter River	0.01 Rt 709; 0.90 Rt 792	-79.34963	37.24541	1%, 0.2%
Wyatts Way/24	Br. of Big Otter River	1.79-Camb Co;0.19-Rt 709	-79.34501	37.24559	1%, 0.2%

Table 4-92 Vulnerable facilities and infrastructures in dam breach zone of Stoney Creek Reservoir Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Pump Station #6	Sewer Pump Station	Peaks Rd / Woods Rd	Bedford	-79.5516	37.3894	1%, 0.2%
Water Pump Station - 5 (Town Of Bedford Water)	Water Booster Pump Station	4690 Peaks Rd	Bedford	-79.5531	37.3897	1%, 0.2%

Stroobants Dam

General information

Stroobants Dam is a DCR-regulated dam located in Bedford County, Virginia, about 1 mile north of where Route 24 crosses Big Otter River. It is a DCR-regulated dam with the regulation agency identified as "undetermined - unknown Dam Initiative (former DRAGNET)".

Dam break inundation zone

Figure 4-73 is an overview of the inundation zone map for the PMF of Stroobants Dam, developed by Hurt & Proffitt in December 2016. The inundation zone of Stroobants Dam shares some common areas with Otter River Raw Water Terminal Reservoir Dam in Campbell County.

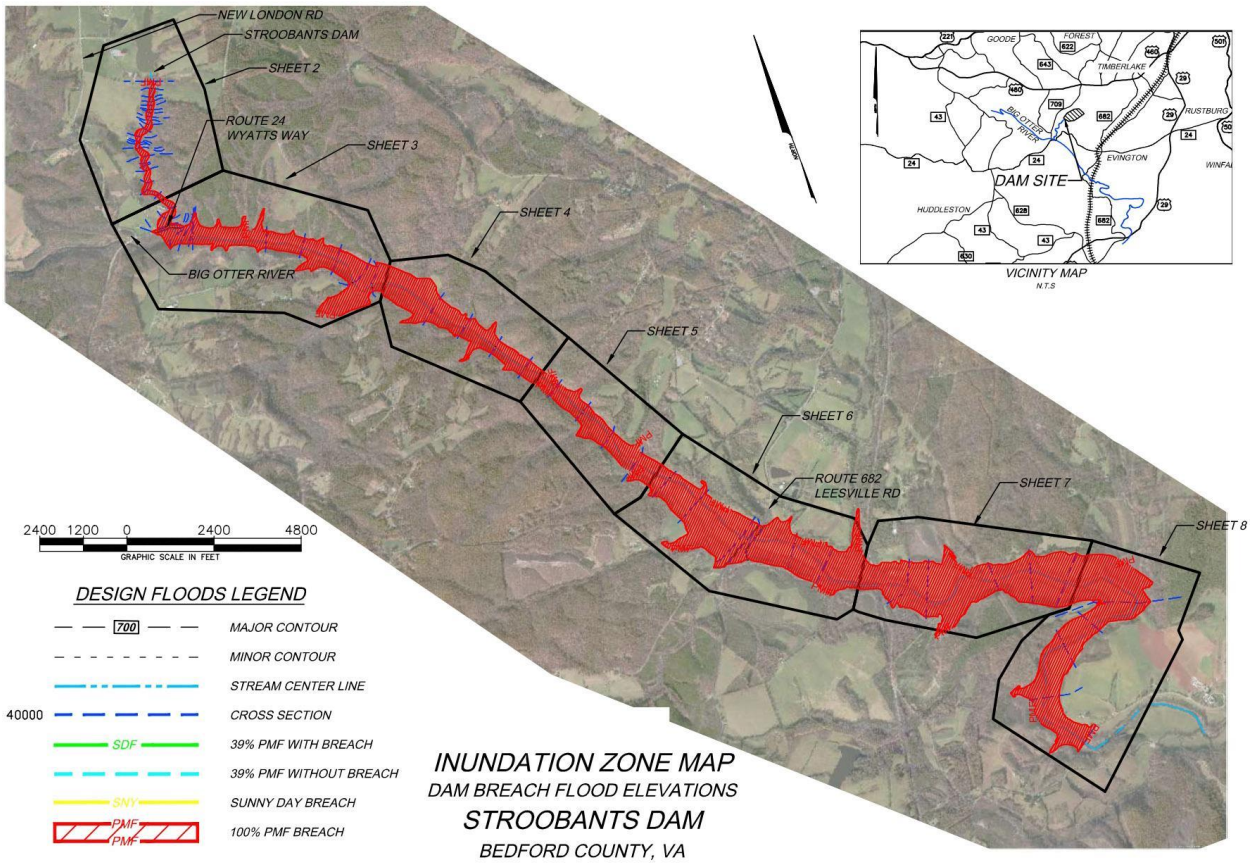


Figure 4-73 Inundation zone map of Stroobants Dam. (Source: Virginia DCR)

Vulnerable structures

Leesville Road (Route 682) and Wyatts Way (Route 24) may be inundated during the dam breach event. Two road bridges and two vulnerable facilities (Campbell County Utility and Service Authority pump station and Walnut Hill historic site) may be impacted (Table 4-93 and Table 4-94).

Table 4-93 Vulnerable road bridges in dam breach scenario of Stroobants Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Leesville Road	Otter River	0.24-Rt.626/0.85-Rt.694	-79.30358	37.20857	1%, 0.2%
Wyatts Way/24	Br. of Big Otter River	1.79-Camb Co;0.19-Rt 709	-79.34501	37.24559	1%, 0.2%

Table 4-94 Vulnerable facilities and infrastructures in dam breach zone of Stroobants Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Walnut Hill	Historic Site	129 Johnson Mountain Rd	Campbell County	-79.3079	37.2088	No
Campbell Co Util And Serv Auth/Sewer Pump Station	Sewer Pump Station	9625 Leesville Rd, Evington	Campbell County	-79.2997	37.2075	1%, 0.2%

Woods Landing Dam

General information

Woods Landing Dam is located adjacent to Woodcock Drive in Bedford County, Virginia, and is owned by the Woods Landing Home Owners Association (WLHOA). The parcel of property encompassing the lake and dam are identified by Bedford County as Tax Map Parcel 30-A-6G. Woods Landing Dam is an earthfill embankment approximately 38.6 feet high, 340 feet long, crest width equal to 10 feet, and a crest elevation equal to 774.8 feet NAVD 88 that creates a maximum pool impounding volume equal to approximately 138 acre-feet. The normal pool elevation is 770.9 feet NAVD 88, with a corresponding normal pool impounding volume equal to approximately 103 acre-feet. Flow from the lake outfalls into a tributary waterway for a short distance, through a culvert at the CSX Railroad, and ultimately into James River.

Dam break inundation zone

Figure 4-74 is an overview of the inundation zone map for the PMF of Woods Landing Dam, completed by Wiley & Wilson in April 2010.

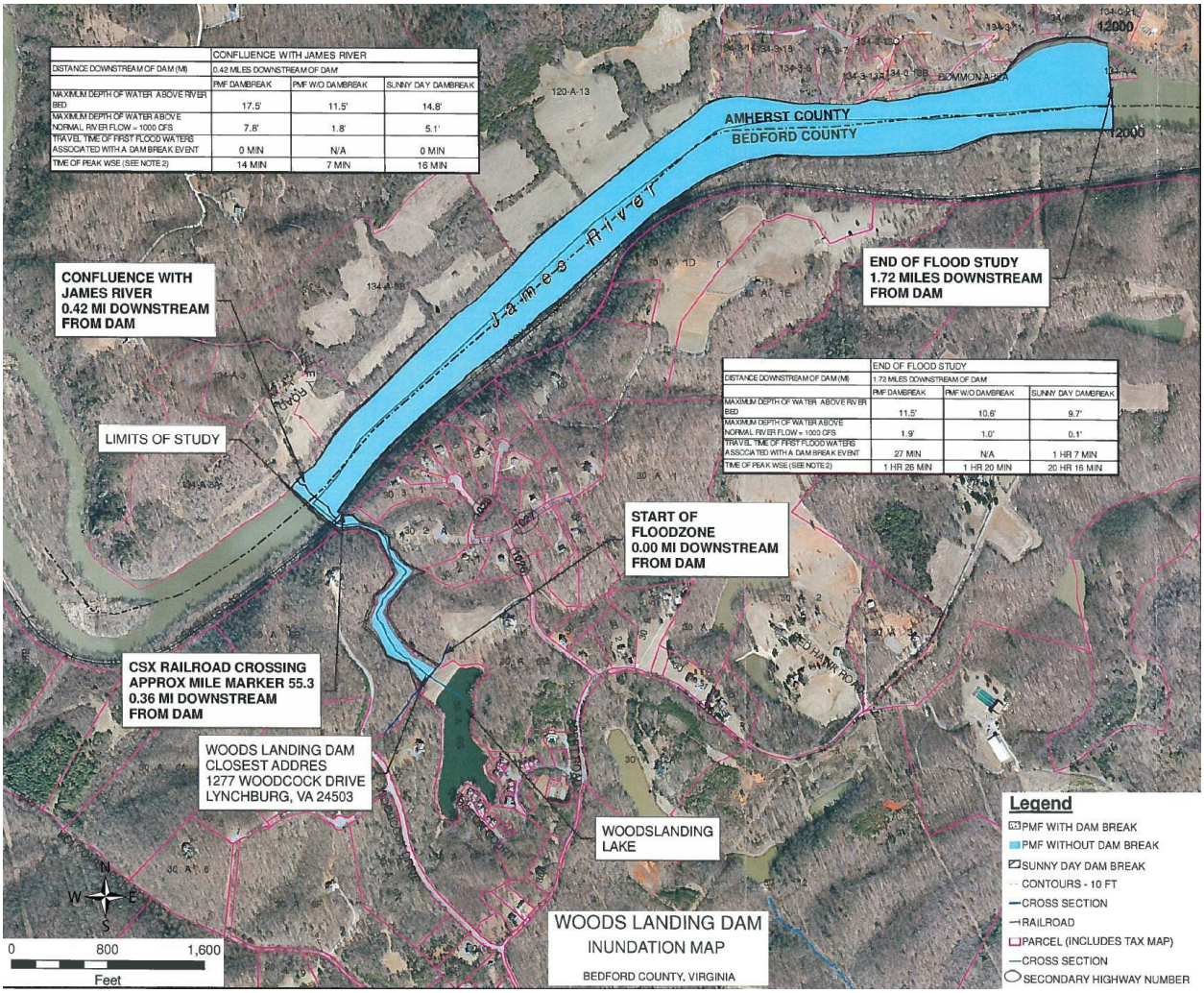


Figure 4-74 Inundation zone map of Woods Landing Dam. (Source: Virginia DCR)

Vulnerable structures

The CSX Railroad crossing approximately 0.36 mile downstream from the Woods Landing Dam (79.25142°W 37.49720°N) may be impacted during a dam breach scenario. There are no vulnerable facilities within the inundation zone. The property within the inundation zone is mostly vacant land or unoccupied residential structures.

4.4.3.4 Campbell County, Altavista, and Brookneal

There are a total of 34 dams within Campbell County recorded in DCR's DSIS inventory (Table 4-95). Of those dams, 22 are of unknown/undetermined category and 2 (6%) dams are classified as high hazard potential (Figure 4-75).

4.4.3.4.1 Principal Dam Breach Problems

The following issues have been identified for dam breach scenarios in Campbell County (also see Table 4-96):

- Vulnerable facilities within the Town of Altavista, including Altavista Power Station, Altavista Fire Company, Altavista Area YMCA Family Center, Altavista Wastewater Plant, Altavista Power Station, several hazmat facilities, and so on are in the maximum inundation area.
- Vulnerable facilities in the maximum inundation zone within the Town of Brookneal: two historical sites, one communication facility, and water treatment plants with associated pump stations.
- Several historic sites, water treatment plants with associated pump stations in the county's incorporated area are in the maximum inundation area
- Several bridge and culvert impacts
- Several residences and businesses in the maximum inundation area
- Nuclear facility property in dam breach maximum inundation area

Table 4-95 Number of Dams in each Hazard Potential Category within Campbell County, Virginia.

Hazard Potential	Number of Dams
HIGH	2
HIGH, SPECIAL	1
SIGNIFICANT	5
LOW	3
LOW, SPECIAL	1
UNKNOWN	22

Table 4-96 Critical facility and infrastructure in dam break inundation area within Campbell County

Facility Name	Facility Type	Address	Coordinates	Floodplain	Inundation Zone
Avoca Museum	Attractions	1514 Main St, Altavista	37.1300, -79.2697	No	Smith Mountain Dam
WODI - AM - The Rain Broadcasting, Inc.	Communication Facility	1230 Radio Road Brookneal, VA 24528	37.0384, -78.9420	1%, 0.2%	Smith Mountain Dam
Altavista Power Station	Energy Facility	104 Wood Lane, Altavista	37.1188, -79.2735	No	Smith Mountain Dam
Leesville Hydro Plant	Energy Facility	Rt. 754, Hurt	37.0931, -79.4022	1%, 0.2%	Smith Mountain Dam
Altavista Fire Company	Fire Stations	1280 Main Street, Altavista	37.1199, -79.2755	No	Smith Mountain Dam
Lane Home Furnishings	HazMat Facility	701 5Th St, Altavista	37.1097, -79.2855	1%, 0.2%	Smith Mountain Dam
Abbott Laboratories - Ross Products Division	HazMat Facility	1516 Main St, Altavista	37.1333, -79.2658	No	Smith Mountain Dam
BGF Industries	HazMat Facility	401 Amherst Avenue, Altavista	37.1122, -79.2782	1%, 0.2%	Smith Mountain Dam
Dominion - Altavista Power Station	HazMat Facility	104 Wood Lane, Altavista	37.1187, -79.2734	No	Smith Mountain Dam

Facility Name	Facility Type	Address	Coordinates	Floodplain	Inundation Zone
Lynchburg Casting Industries	HazMat Facility	1132 Mt Athos Rd	37.4027, -79.0595	0.2%	Reusens Dam
Cat Rock Sluice	Historic Site	Brookneal	37.0436, -78.9599	1%, 0.2%	Smith Mountain Dam
Green Hill	Historic Site	378 Pannills Rd, Gladys	37.0621, -79.0722	No	Smith Mountain Dam
Red Hill	Historic Site	1430 Red Hill Rd, Brookneal	37.0322, -78.8980	No	Smith Mountain Dam
The Mansion	Historic Site	1580 Mansion Bridge Rd, Altavista	37.1246, -79.2399	No	Smith Mountain Dam
Walnut Hill	Historic Site	129 Johnson Mountain Rd, Evington	37.2088, -79.3079	No	Otter River Raw Water Terminal Reservoir Dam; Stroobants Dam
Six Mile Bridge	Historic Site	Mount Athos Rd & James River	37.3932, -79.0612	1%, 0.2%	Ivy Lake Dam; Reusens Dam
Altavista Area YMCA Family Center	Large Population Venue	1000 Franklin Ave, Altavista	37.1140, -79.2889	1%, 0.2%	Smith Mountain Dam
Altavista Police Department	Law Enforcement	510 7Th Street, Altavista	37.1103, -79.2899	No	Smith Mountain Dam
Campbell Co Util And Serv Auth/Sewer Pump Station	Sewer Pump Station	9625 Leesville Rd, Evington	37.2075, -79.2997	1%, 0.2%	Otter River Raw Water Terminal Reservoir Dam; Stroobants Dam
Brookneal Town - Falling River	Wastewater Treatment Plant	Wickliffe Ave, Brookneal	37.0522, -78.9340	1%, 0.2%	Smith Mountain Dam
Brookneal Town - Staunton River	Wastewater Treatment Plant	Radio Rd, Brookneal	37.0376, -78.9391	1%, 0.2%	Smith Mountain Dam
Altavista Wastewater Plant	Wastewater Treatment Plant	Ln Access Rd, Altavista	37.1123, -79.2740	1%, 0.2%	Smith Mountain Dam
Altavista Water Treatment Plant	Wastewater Treatment Plant	20 Ricky Van Shelton Dr, Hurt	37.1045, -79.2833	No	Smith Mountain Dam
Otter River Water Treatment Plant	Wastewater Treatment Plant	9605 Leesville Rd, Evington	37.2113, -79.2988	No	Otter River Raw Water Terminal Reservoir Dam
Otter River Water Tank	Water Storage Facility	9625 Leesville Rd, Evington	37.2109, -79.2992	No	Otter River Raw Water Terminal Reservoir Dam

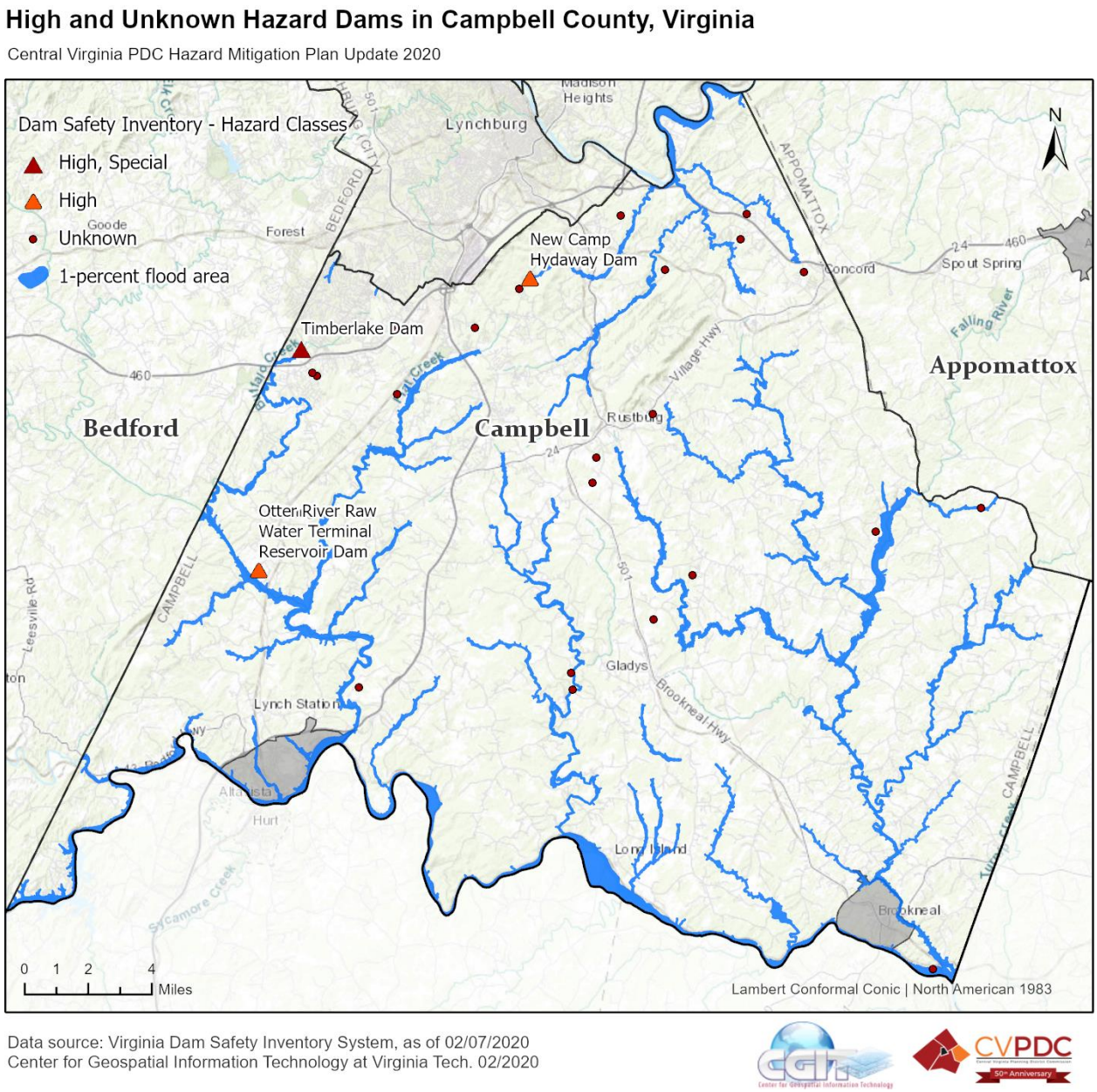


Figure 4-75 Location of High and Unknown hazard dams in Campbell County, Virginia.

4.4.3.4.2 Risk Analysis of Individual Dams

New Camp Hydaway Dam

General information

New Camp Hydaway Dam is located south of the City of Lynchburg in Campbell County, Virginia, just upstream of Route 677 along Opossum Creek and approximately 2,500 feet downstream of the existing Camp Hydaway Dam. The dam creates a 37-acre impoundment used for recreation. The drainage area at the dam is 2.69 square

miles. The reservoir flood storage capacity is 915 acre-feet at the emergency spillway crest elevation, 813.5 feet. Downstream of the dam, Opossum Creek passes under VA Route 677 (Camp Hydaway Road) and then passes under several railroads and roads (including VA Route 677 Camp Hydaway Road, Route 669 Lone Jack Road, Route 501 Campbell Highway, Route 660 Eastbrook Road, and Route 460 Richmond Highway) before flowing into James River. This structure is classified as High Hazard Potential.

Note: The New Camp Hydaway Dam, Inventory No. 031035 is not constructed yet. Issuance of a DCR impounding structure construction permit for this dam is not anticipated until late Spring/early Summer 2020. The existing Camp Hydaway Dam, Inventory No. 031013 is currently present upstream of the proposed new and enlarged lake. The existing dam/lake will be decommissioned as part of the overall construction plan of new and enlarged dam/lake.

Dam Break Scenario

Figure 4-76 is an overview map of the inundation zone for the PMF of New Camp Hydaway Dam, prepared by Geoffrey L. Cowan in October 2019 for the temporary EAP for final construction permit application for the dam.

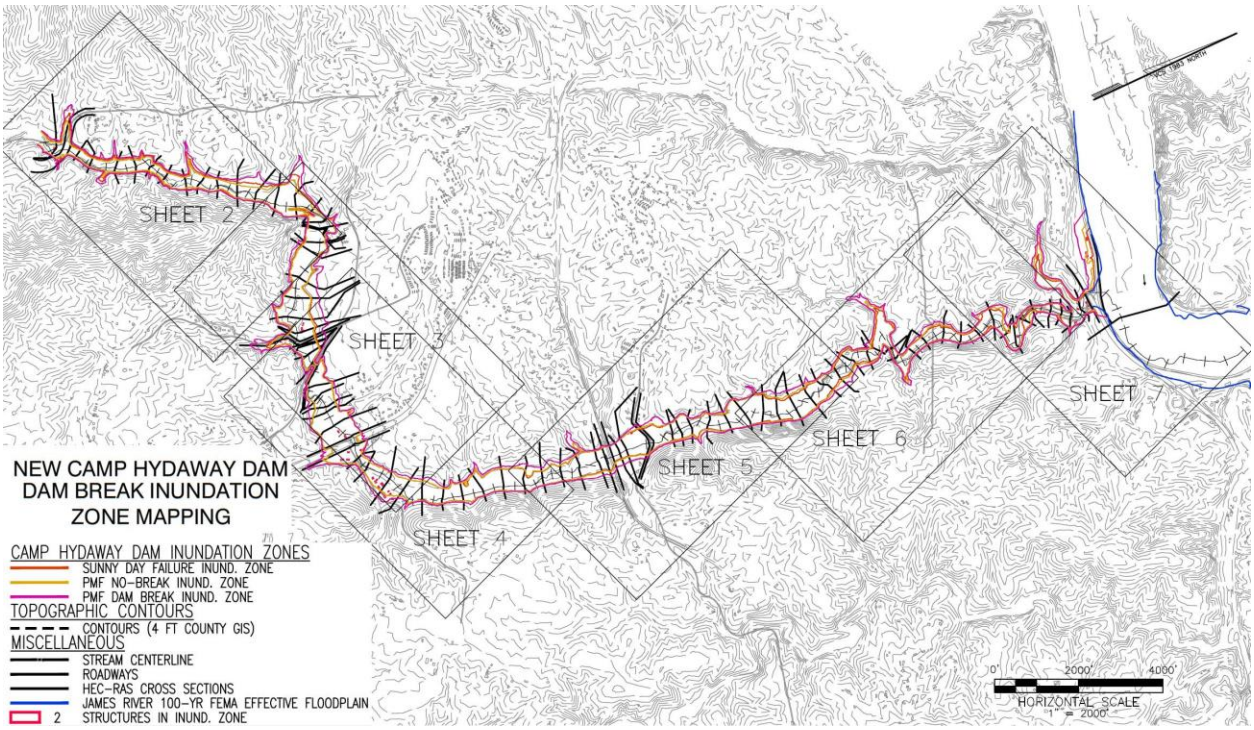


Figure 4-76 Inundation zone map of New Camp Hydaway Dam. (Source: Virginia DCR)

Vulnerable structures

Three road bridges may be impacted during a dam breach event (Table 4-97). No critical facilities are found in the inundation zone.

Table 4-97 Vulnerable road bridges in dam breach scenario of New Camp Hydaway Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Opossum Creek	Camp Hydaway Road	1.60-Rt 664/1.48-Rt 1480	-79.1424	37.34468	1%, 0.2%
Opossum Creek	Eastbrook Road	1.10-Rt 665/2.20-Rt 662	-79.0902	37.35913	1%, 0.2%
Opossum Creek	NBL Campbell Hwy	1.87-Lynch CL/0.01-Rt 667	-79.1063	37.34481	1%, 0.2%

Otter River Raw Water Terminal Reservoir Dam

General information

The Otter River Raw Water Terminal Reservoir is a 42-foot tall impounding structure designed for water production in 1989. Surface water does not flow into the reservoir. Water is pumped into it from Big Otter River, which is approximately 0.2 miles downhill from the reservoir. Big Otter River is a tributary to Roanoke River in Campbell County, Virginia south of the Town of Evington. The water treatment plant is located within 150-feet of the toe of the reservoir embankment and one home is located downhill of the water treatment facility. Depending upon the location of a dam breach, the water treatment plant may or may not be directly in the path of the flood waters. If the dam were to breach directly above the water treatment plant, the plant would be significantly damaged and loss of life would be probable if it were occupied at the time. This reservoir is therefore classified as having a High Hazard Potential.

Dam Break Scenario

Figure 4-77 is an overview map of the inundation zone for the PMF of Otter River Raw Water Terminal Reservoir Dam, completed by Prepared by Hurt & Proffitt, Inc. in April 2018 for the EAP of the dam.

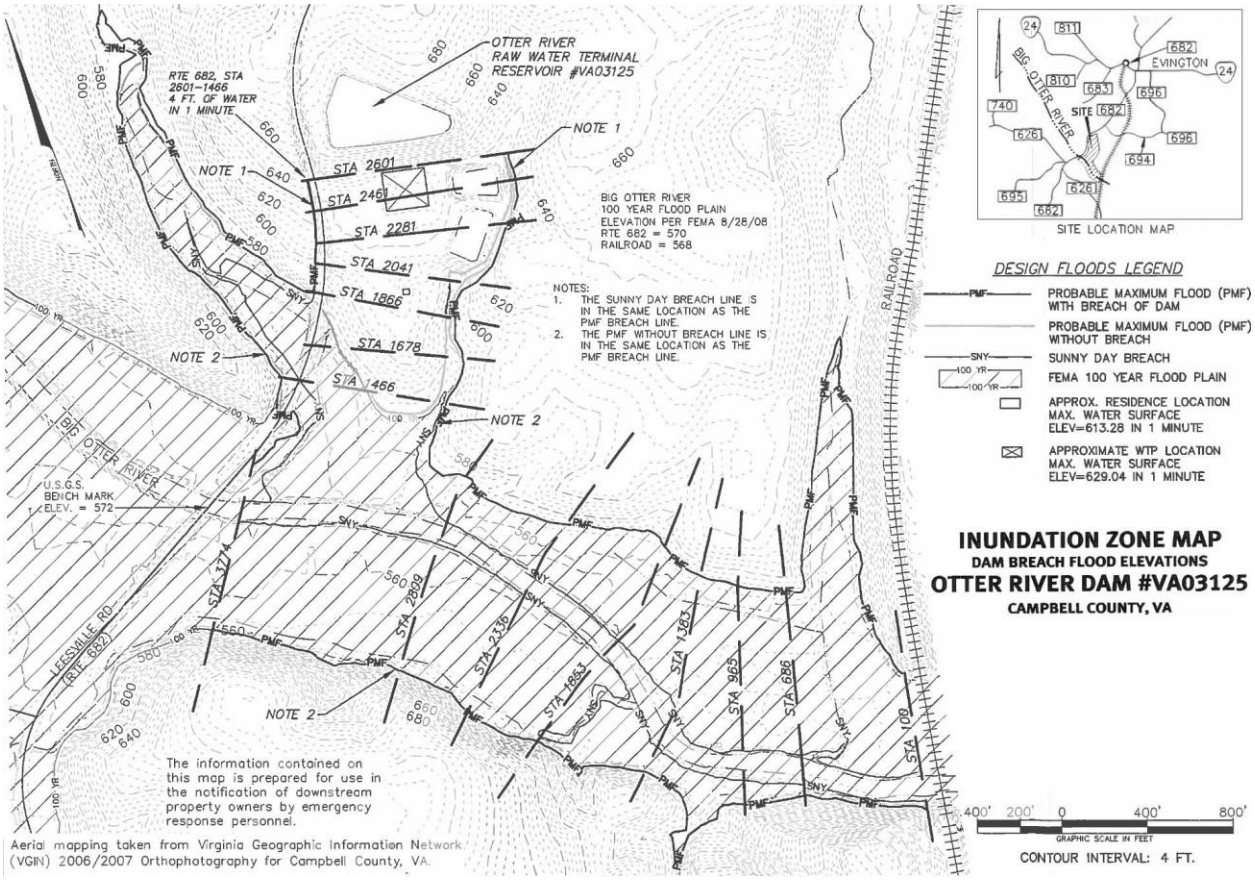


Figure 4-77 Inundation zone map of Otter River Raw Water Terminal Reservoir Dam. (Source: Virginia DCR)

Vulnerable structures

The Otter River Water Treatment Plant and associated water tank and sewer pump station are in the inundation zone, along with Walnut Hill historic site (Table 4-98). Leesville Rd. would be impacted during dam failure. No road bridges are found in the inundation zone.

Table 4-98 Vulnerable facilities and infrastructures in dam breach zone of Otter River Raw Water Terminal Reservoir Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Walnut Hill	129 Johnson Mountain Rd, Evington	Historic Site	Campbell	-79.3079	37.2088	No
Otter River Water Tank	9625 Leesville Road	Water Storage Facility	Campbell	-79.2992	37.2109	No
Otter River Water Treatment Plant	9605 Leesville Rd, Evington	Wastewater Treatment Plant	Campbell	-79.2988	37.2113	No
Campbell Co Util And Serv Auth/ Sewer Pump Station	9625 Leesville Rd, Evington	Sewer Pump Station	Campbell	-79.2997	37.2075	1%, 0.2%

Timberlake Dam

General information

The Timberlake Dam is located at the end of Timberlake Drive, Lynchburg. The dam is classified as a High Hazard Dam as determined by the Hazard Classifications performed by Hurt and Proffitt. It creates a 57-acre impoundment used for recreation. The drainage area is approximately 3,174.4 acres or 4.96 square miles. The reservoir flood capacity storage is 1,449 acre-feet at the emergency spillway crest, elevation 813.6 feet. This site is operated by the Timberlake Homeowners Association in Campbell County.

Dam break inundation zone

Downstream of the Timberlake Dam, Buffalo Creek flows through commercial and residential areas. Figure 4-78 shows the inundation zone for the PMF of the dam, digitized from a scan of EAP map. The original map was completed by Hurt & Proffitt, Inc. in June 2019.

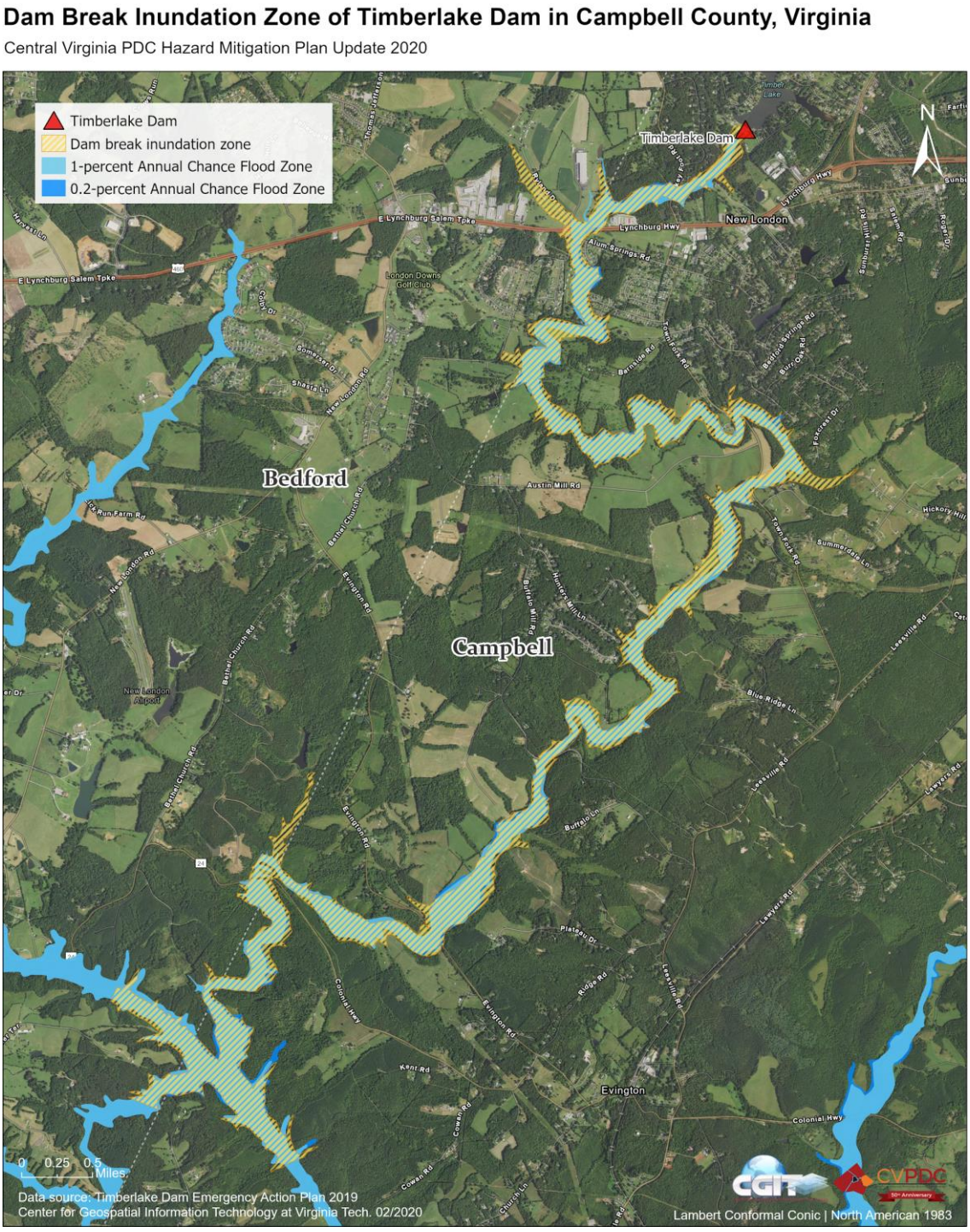


Figure 4-78 Inundation zone map of Timberlake Dam. (Source: Virginia DCR)

Vulnerable structures

Several roads are subject to inundation during a dam breach even, including Turkeyfoot Road (Route 623), Lynchburg Highway (Route 460), Alum Springs Road (Route 858), Town Fork Road (Route 623), Evington Road

(Route 811) and Wyatts Way Road (Route 24). Eight road bridges may also be impacted (Table 4-99). No critical facilities are found in the inundation zone.

Table 4-99 Vulnerable road bridges in dam breach zone of Timberlake Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Wyatts Way/24	Buffalo Creek	0.11 Camp Co; 7.54 Rt 43E	-79.3242	37.25219	1%, 0.2%
Alum Spgs. Rd 858	Buffalo Creek	0.02 Rt 649; 0.02 Cpbl Co	-79.291	37.30425	1%, 0.2%
Route 460 WBL	Buffalo Creek	0.06-Bed Co/1.34-460 Bus	-79.2899	37.30508	1%, 0.2%
Town Fork Road	Buffalo Creek	0.06-Rt.1594/0.30-Rt.625	-79.273	37.2841	1%, 0.2%
Turkeyfoot Road	Buffalo Creek	.19-Rt 460 / .18-Rt 1400	-79.2812	37.30777	1%, 0.2%
Evington Road	Buffalo Creek	0.60-Rt 934/2.10-Bedfo CL	-79.3052	37.24731	1%, 0.2%
Town Fork Road	Buffalo Creek	0.65-Rt.871 / 0.15-Rt.625	-79.2747	37.29001	1%, 0.2%
Buffalo Mill Road	Buffalo Creek	2.93 Rt 625/1.37 Rt 682	-79.2947	37.26195	No

4.4.3.5 City of Lynchburg

There are a total of 6 dams within the City of Lynchburg recorded in DCR DSIS inventory (Table 4-100). Of those dams, 2 are of unknown/undetermined category and 3 (50%) are classified as High Hazard Potential, including College Lake Dam, Lake Summit Dam, and Lakeland Dam (Figure 4-79).

The City of Lynchburg Open Data Portal provides the inundation zone GIS dataset for high hazard dams in the city. It is worth noting that digitized EAP maps (or DBIZ maps) for high hazard dams elsewhere in the PDC are unavailable from DCR or local governments. Geospatial boundaries from dam inundation studies facilitate more accurate risk assessment and make loss analyses possible (as in this section). They should be considered in the future plan update for other jurisdictions once available.

4.4.3.5.1 Principal Dam Breach Problems

The following issues have been identified for dam breach scenarios in the City of Lynchburg:

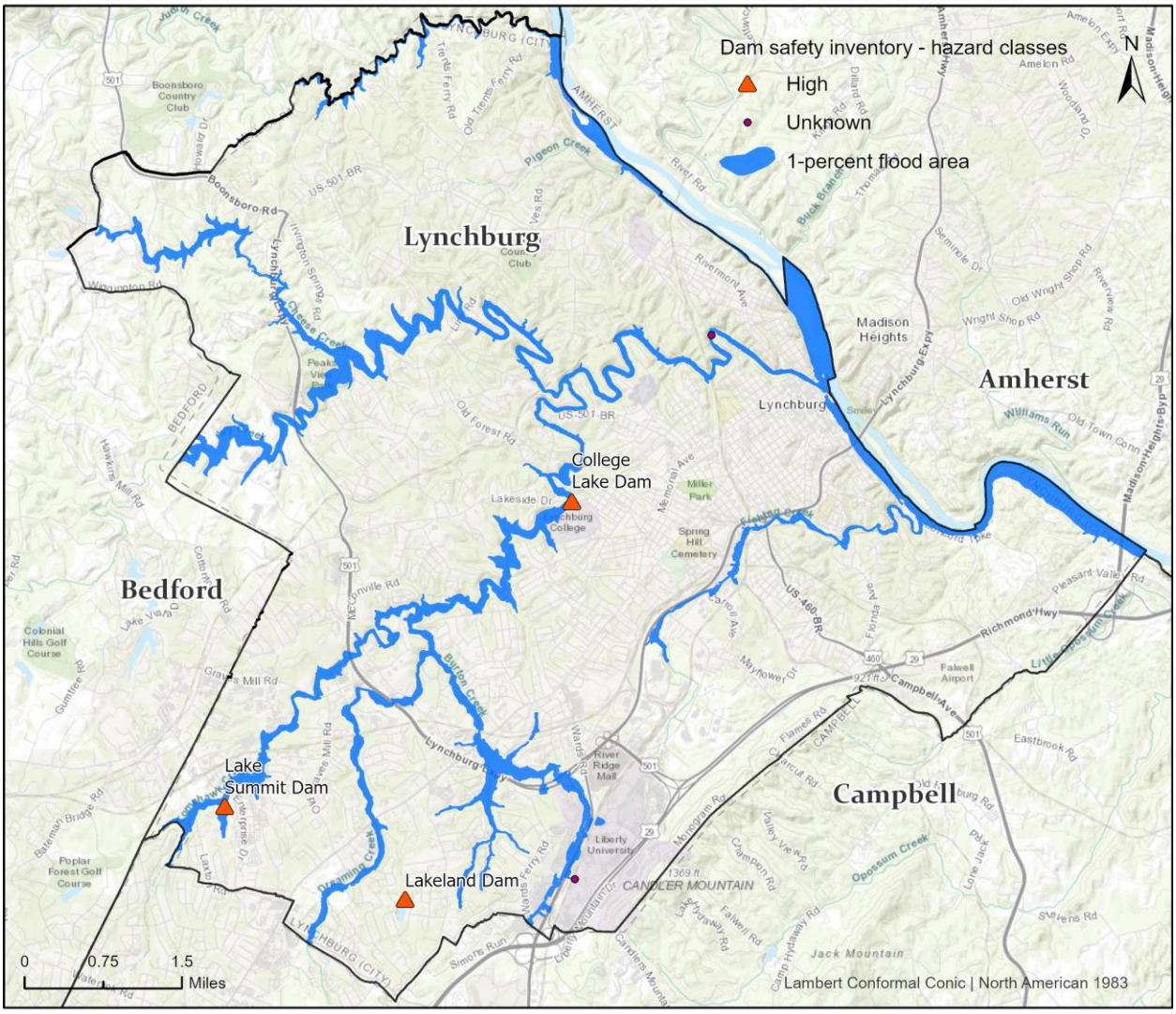
- Four electrical substations
- Water treatment plant
- Children's Museum
- Lynchburg Expy, Lakeside Drive, and Timberlake Rd
- CSX Transportation Railroad and Norfolk Southern Railroad impacts
- Several bridge and culvert impacts
- Several residences and businesses in the maximum inundation area (some outside the 100-year floodplain)
- Redevelopment area overlaps with the dam breach inundation area
- Recent high hazard dam breach (College Lake Dam)

Table 4-100 Number of Dams in each Hazard Potential Category within Lynchburg City, Virginia.

Hazard Potential	Number of Dams
HIGH	3
HIGH, SPECIAL	0
SIGNIFICANT	0
LOW	1
LOW, SPECIAL	0
UNKNOWN	2

High and Unknown Hazard Dams in Lynchburg City, Virginia

Central Virginia PDC Hazard Mitigation Plan Update 2020



Data source: Virginia Dam Safety Inventory System, as of 02/07/2020
Center for Geospatial Information Technology at Virginia Tech. 02/2020

Figure 4-79 Location of High and Unknown hazard dams in Lynchburg City, Virginia.

4.4.3.5.2 Vulnerable Population

The high hazard dams within Lynchburg, as well as outside dams near the city border (Ivy Lake Dam and Reusens Dam), account for approximately 6,270 acres total inundation areas across the City of Lynchburg and surrounding jurisdictions. Of these inundation areas, there are about 1,800 acres (8% of the entire area of the city) within the boundary of Lynchburg. The vulnerable populations within or near the inundation zone include 16.5% of the young and 18.7% of the old population, 14.9% of the black population and 12.7% of the Native American population (also see Figure 4-80, Figure 4-81, Figure 4-82, and Figure 4-83). Table 4-101 describes these demographic profiles of the downstream inundation areas from the dams and compares those to the overall demographic makeup of the city.

Table 4-101 Comparison of demographics in DBIZ and in City of Lynchburg (Source: US Census 2010)

	Young Population (age <18)	Old Population (age>65)	White Population	Black Population	Native American Population
Lynchburg City (Total)	14,773	10,551	48,670	22,138	237
DBIZ area (Total)	2,441	1,977	6,913	3,295	30
DBIZ area (Percentage)	16.5%	18.7%	14.2%	14.9%	12.7%

4.4.3.5.3 Critical Facilities and Infrastructure

The Amazement Square Child Museum and electrical substation near James River are located in the dam inundation zones of Lynchburg's high hazard dams. The Reusens Dam Hydro Plant and one of its electrical substations sit in the Reusens Dam (Amherst County) inundation zone which traverses the city; the Westrock Converting Company, U.S. Pipe, and Lynchburg Foundry Co. Lower Basin Plant are found in the Ivy Lake Dam (Bedford County) inundation zone (Table 4-102).

Table 4-102 Critical facility and Infrastructure in dam break inundation zone within City of Lynchburg

Facility Name	Address	Facility Type	Coordinate	Floodplain	Inundation Zone
Amazement Square Child Museum	27 9Th St, Lynchburg	Attractions	37.4162, -79.1403	0.2%	College Lake Dam
Electrical Substation	127 Stonewall St, Lynchburg	Electrical Substation	37.4194, -79.1447	No	College Lake Dam
Electrical Substation	4370 Hydro St, Lynchburg	Electrical Substation	37.4622, -79.1872	1%; 0.2%	Reusens Dam (Amherst)
Reusens Dam Hydro Plant	4300 Hydro Street, Lynchburg	Energy Facility	37.4630, -79.1867	1%; 0.2%	Reusens Dam (Amherst)
Westrock Converting Company	1801 Concord Turnpike, Lynchburg	HazMat Facility	37.4034, -79.1281	1%; 0.2%	Ivy Lake Dam (Bedford)
U.S. Pipe	10 Adams Street, Lynchburg	HazMat Facility	37.4208, -79.1413	1%; 0.2%	Ivy Lake Dam (Bedford)

Facility Name	Address	Facility Type	Coordinate	Floodplain	Inundation Zone
Lynchburg Foundry Co Lower Basin Plant	Garnet Street And Concord Turnpike	HazMat Facility	37.4071, -79.1318	1%; 0.2%	Ivy Lake Dam (Bedford)

Note: The inundation zone formed by high hazard dams in both Lynchburg and adjacent jurisdictions near the city border are taken into account.

4.4.3.5.4 Community Growth Areas

Lynchburg's Comprehensive Plan 2013-2030 includes 19 locations as the community's future growth areas. These areas include Revitalization Areas, which focus on encouraging reinvestment and sensitive redevelopment in older commercial districts, and Development/Redevelopment Areas which focus on encouraging coordinated planning for large tracts of vacant, developable land that incorporates smart growth techniques on key gray-field and green-field sites throughout the City (Figure 4-84). Most of these growth areas don't overlap with the inundation zone, except the Downtown area near James River, and the Wyndhurst area, which includes Tomahawk Creek.

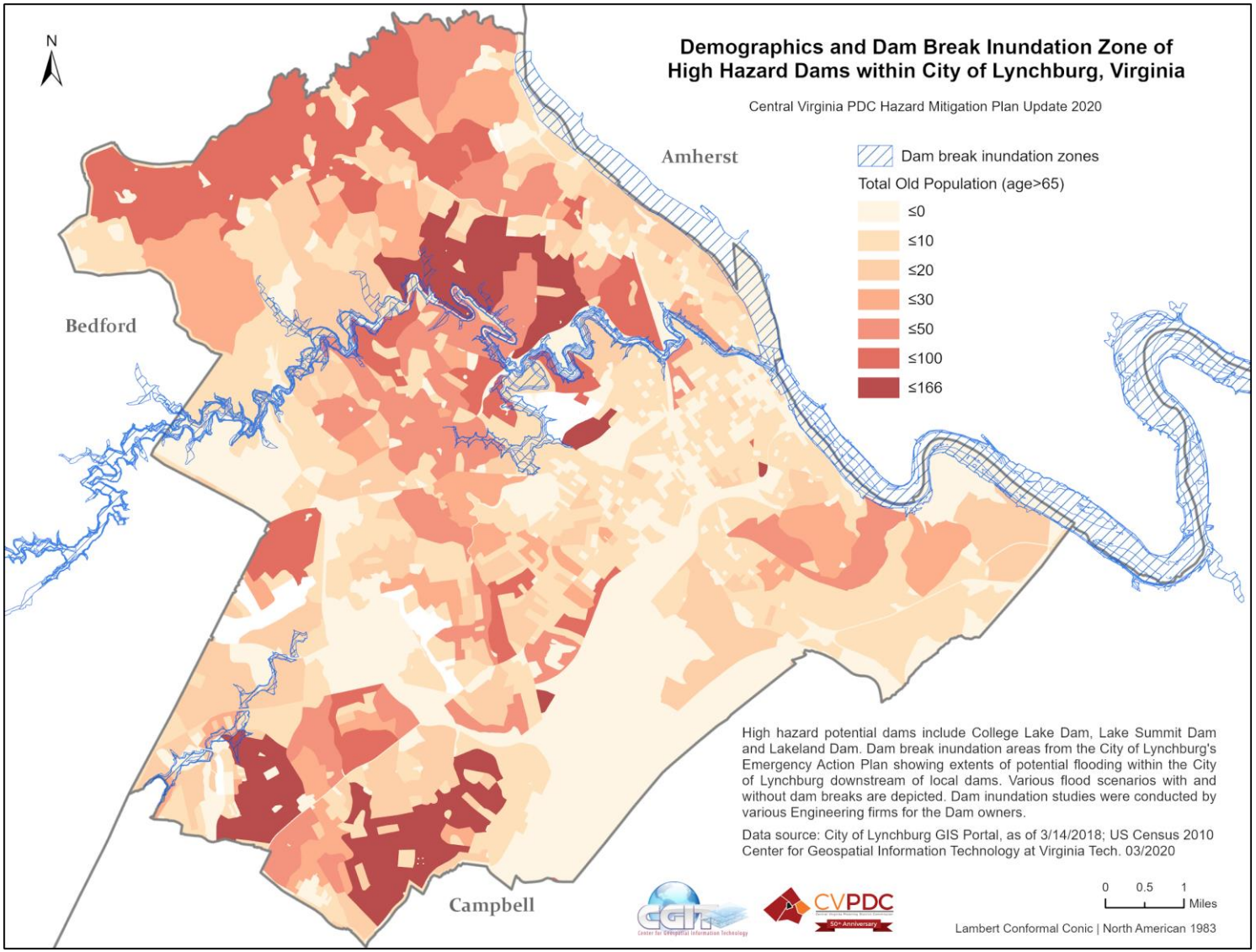


Figure 4-80 Demographics in dam break inundation zone of high hazard dams within City of Lynchburg, Virginia: Total old population (age > 65)

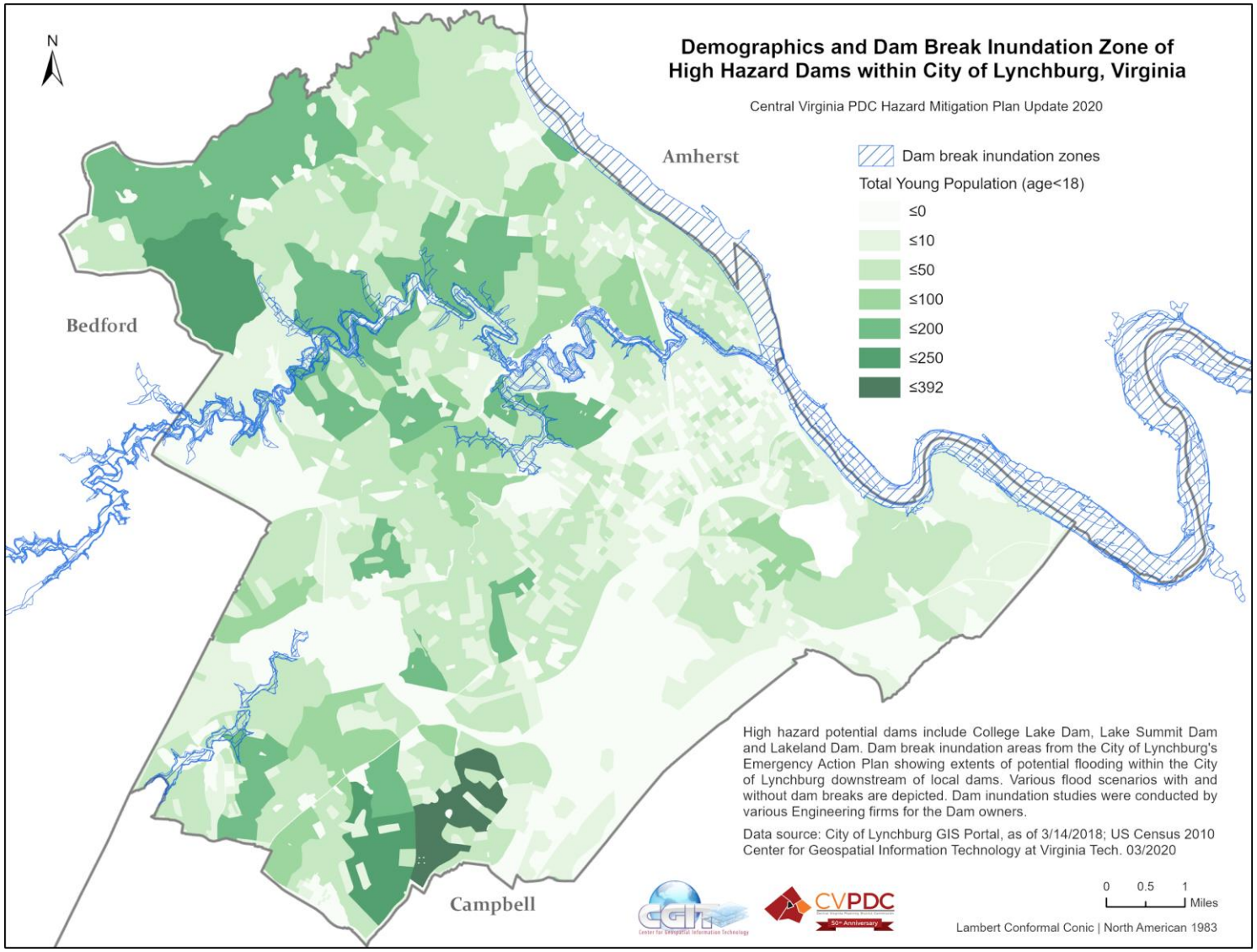


Figure 4-81 Demographics in dam break inundation zone of high hazard dams within City of Lynchburg, Virginia: Total young population (age < 18)

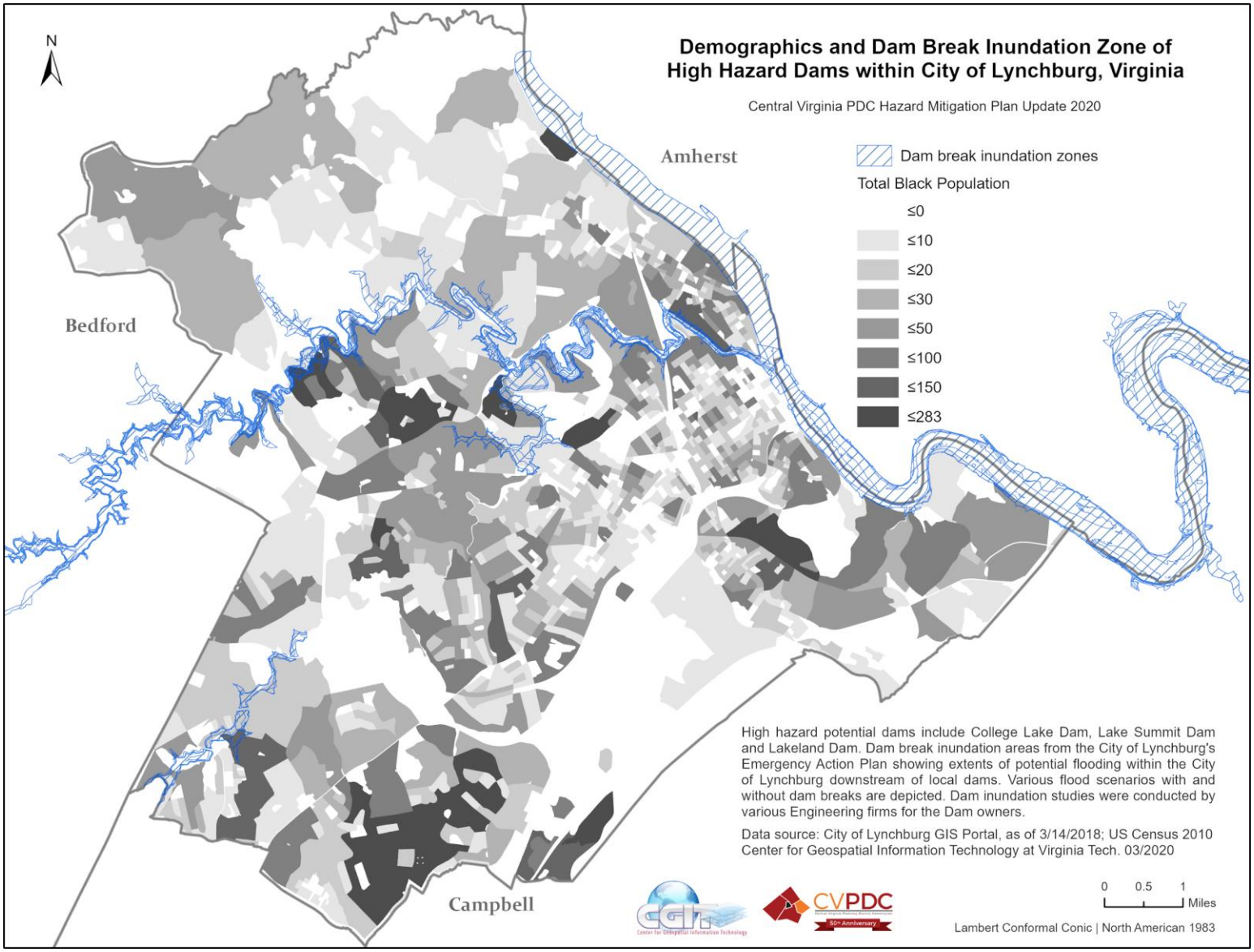


Figure 4-82 Demographics in dam break inundation zone of high hazard dams within City of Lynchburg, Virginia: Total Black population

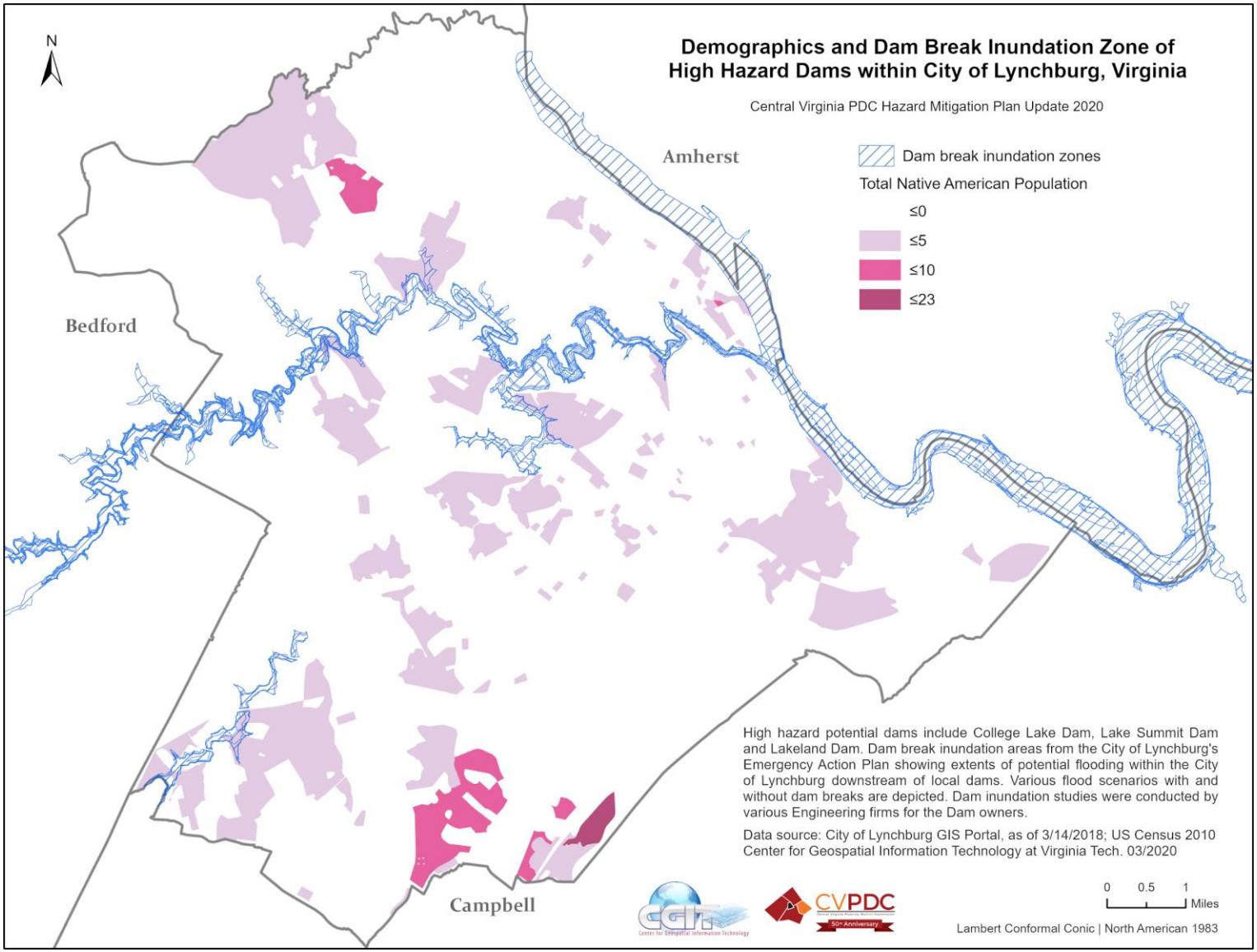


Figure 4-83 Demographics in dam break inundation zone of high hazard dams within City of Lynchburg, Virginia: Total Native American population

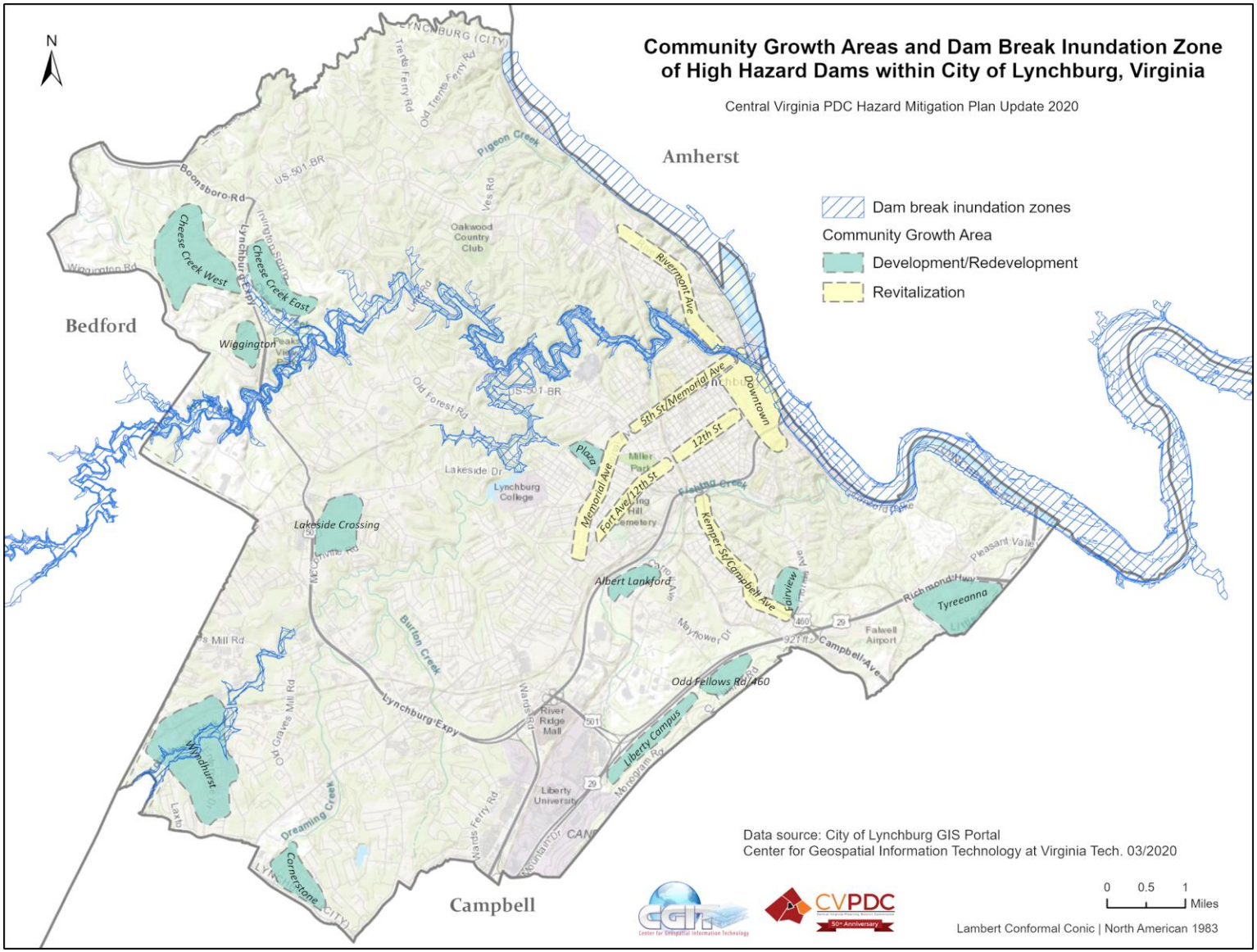


Figure 4-84 Community growth areas and dam break inundation zone of high hazard dams within City of Lynchburg, Virginia

4.4.3.5.5 Risk Analysis of Individual Dam

Lake Summit Dam

General information

Lake Summit Dam is situated on Tomahawk Creek, approximately 0.2 miles upstream of Enterprise Drive (Rt. 1415) in Lynchburg, Virginia. The dam impounds Summit Lake, an approximate 8-acre reservoir at normal pool. The drainage area to the Summit Dam was calculated to be 1.1 square miles (706 acres) and predominantly consists of developed areas. Summit Dam was constructed as a recreational impoundment. The dam is 28 feet tall with a crest elevation of 761.6 feet and a normal pool elevation of 754.0 feet. The principal spillway consists of a 5-foot diameter concrete inlet tower with a 5-foot diameter outfall pipe. The exit channel discharges into the natural channel. The auxiliary spillway is located along the dam's left abutment with a grass control section and a bottom width of 30 feet. The spillway is reported to have a design capacity exceeding the 1-percent annual chance flood event. The dam is currently classified as a high hazard structure.

Dam break inundation zone

Figure 4-85 is the inundation zone map for the PMF of Lake Summit Dam. The digital format of the inundation zone boundary was provided by the City of Lynchburg GIS Portal.[32] The original data was developed as part of the EAP for the dam prepared May 29, 2014 by Froehling & Robertson, Inc.

[32] Know My Zone! Flood and Dam Inundation Zone Look Up - Map.
https://www.arcgis.com/home/item.html?id=aea88b27b83943caa6a86b5411c475c5

Dam Break Inundation Zone of Lake Summit Dam, Lynchburg, Virginia

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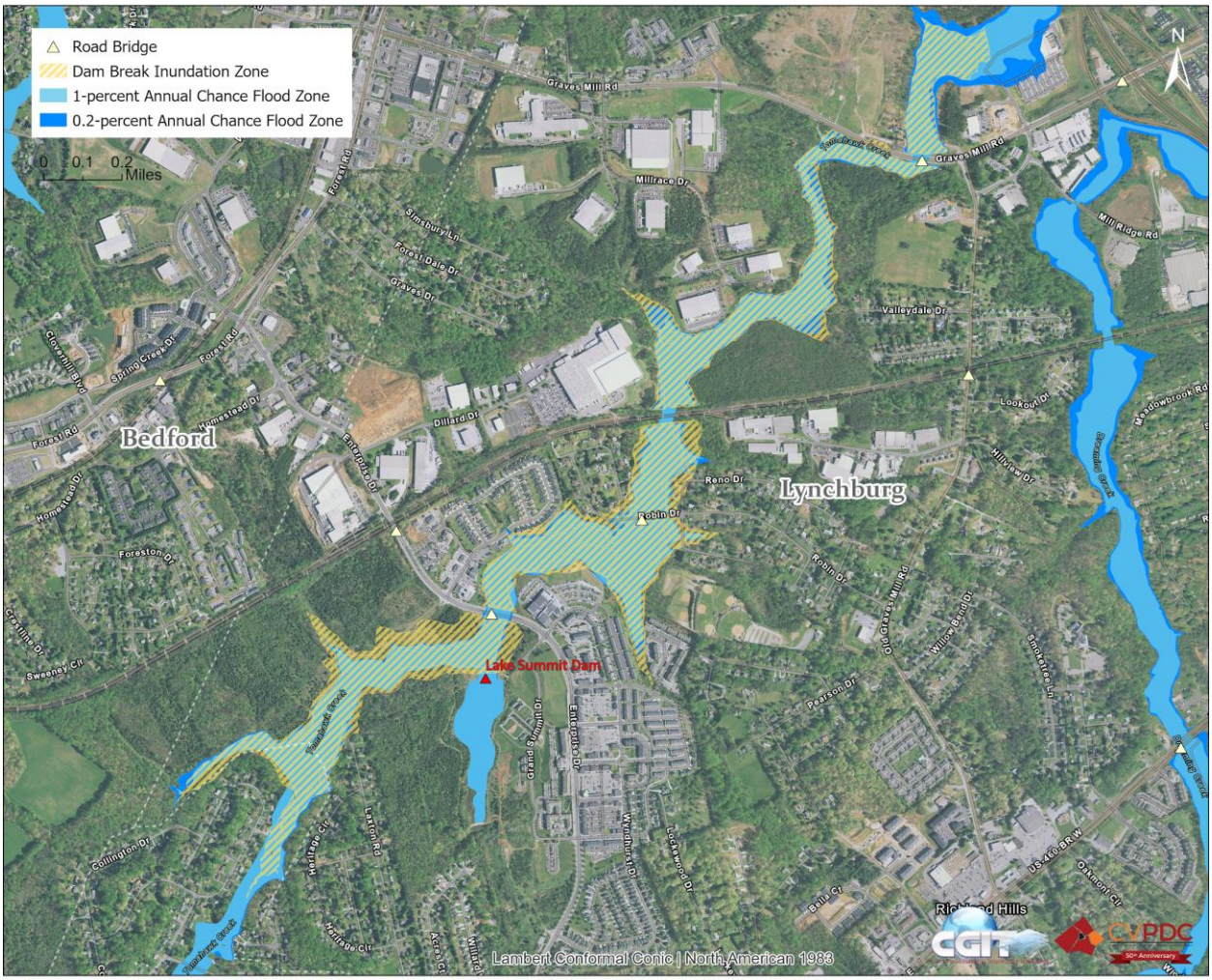

Dam Inundation areas from the City of Lynchburg's Emergency Action Plan showing extents of potential flooding within the City of Lynchburg downstream of local dams. Various flood scenarios with and without dam breaks are depicted. Dam inundation studies were conducted by various Engineering firms for the Dam owners.

Data source: City of Lynchburg GIS Portal, as of 3/14/2018
Center for Geospatial Information Technology at Virginia Tech. 04/2020

Figure 4-85 Inundation zone map of Lake Summit Dam. (Source: Virginia DCR)

Vulnerable structures

These roads may be impacted during a dam breach scenario: Graves Mill Road, Springvale Drive, Reno Drive, and Little Creek Road. Table 4-103 lists several vulnerable road bridges within the inundation zone. There is no critical facility in the zone.

Table 4-103 Vulnerable road bridges and tunnels in dam breach scenario of Lake Summit Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Graves Mill Road	Tomahawk Creek	1.20RT221/.02 OLDGRVSMILL	-79.2282	37.3748	1%, 0.2%
Robin Drive	Tomahawk Creek	0.04 LCR - 0.56 OGMR	-79.2385	37.3642	1%, 0.2%
Enterprise Drive	Tomahawk Creek	.7 FR 661 / 1.0 RT. 1520	-79.2441	37.361	1%, 0.2%

Lakeland Dam

General information

Lakeland Dam is a recreational dam that is located in Lynchburg, Virginia. It is an earthen dam and is approximately 550 feet long and 25.2 feet high. The width of the crest of the dam is 12.0 feet with an elevation of 858.5 feet. Lakeland Lake has a drainage area of 0.28 square miles and is 8.3 acres in area when the water level is at the primary spillway elevation of 854.0 feet. The discharge for the dam releases into a tributary that feeds into Dreaming Creek, which is located about one mile downstream from the dam. The dam is owned and operated by the Lakeland Club, Inc.

Dam break inundation zone

Figure 4-86 is the inundation zone map for the PMF of Lakeland Dam, digitized from a scan of the EAP of the dam. The original map was prepared by Warner White Engineering Partners, Inc., in February 2013.

Dam Break Inundation Zone of Lakeland Dam, Lynchburg, Virginia

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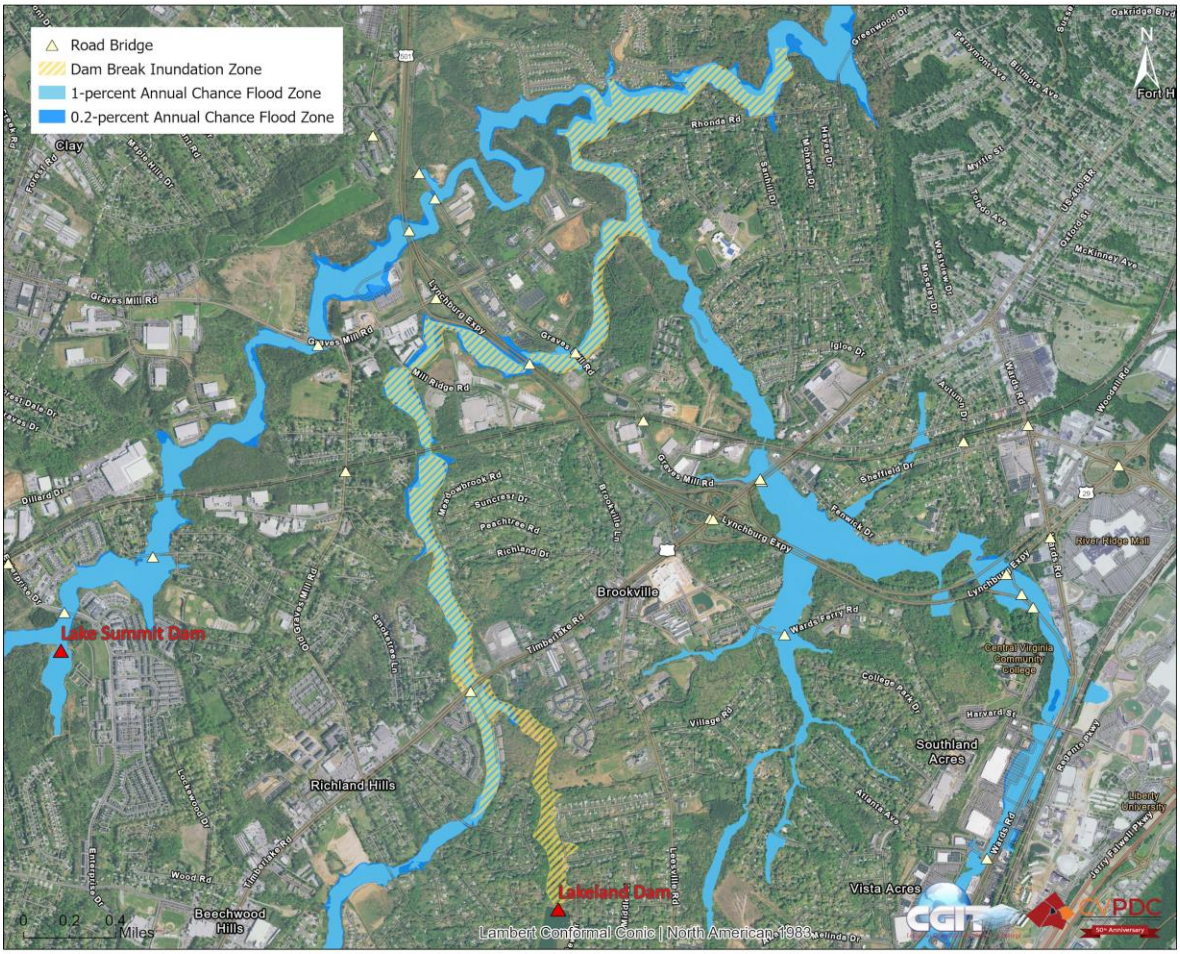


Dam Inundation areas from the City of Lynchburg's Emergency Action Plan showing extents of potential flooding within the City of Lynchburg downstream of local dams. Various flood scenarios with and without dam breaks are depicted. Dam inundation studies were conducted by various Engineering firms for the Dam owners.

Data source: Lakeland Dam Emergency Action Plan 2013
Center for Geospatial Information Technology at Virginia Tech. 04/2020

Figure 4-86 Inundation zone map of Lakeland Dam. (Source: Virginia DCR)

Vulnerable Structures

The following roads may be impacted during a dam breach scenario: primary roads, including Lynchburg Expy (near Exit 11) and Timberlake Rd; and local secondary roads including Mill Ridge Rd, Graves Mill Rd, Takoma St, Lawton Ln, and Rhonda Rd. Table 4-104 lists the vulnerable road bridges within the inundation zone.

Table 4-104 Vulnerable road bridges and tunnels in dam breach scenario of Lakeland Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Timberlake Road	Dreaming Creek	0104291 EXP 0110CAMPB CL	-79.2186	37.3575	1%, 0.2%
Graves Mill Road	Dreaming Creek	.08 L.Bowen Dr .2 Old Mil	-79.212	37.3744	1%, 0.2%

College Lake Dam

General information

College Lake Dam is a High Hazard Potential earth embankment dam designed by the Virginia Highway Department (now the Virginia Department of Transportation) and constructed in 1934. Lakeside Drive (US Route 221) is a two-lane, heavily trafficked road that runs along the dam crest. The dam impounds College Lake, a recreational impoundment owned by the University of Lynchburg. The dam is located on Blackwater Creek, 7.32 miles upstream from its confluence with James River in downtown Lynchburg.

The dam is a 35.4 foot high earth embankment dam with a central clay core. The dam is about 300 feet long, with a crest width of about 54 feet. The upstream slope of the dam is approximately 2.25:1 (horizontal to vertical) and is partially armored with riprap. The original masonry primary spillway at the east abutment built in 1939 was removed about 1960, leaving a 60 foot wide uneven exposed rock cut which now serves as the principal spillway. No emergency spillway has ever existed. Freeboard at normal water level is approximately 11 feet. A concrete arch bridge carrying Lakeside Drive spans this spillway with the bridge abutments defining each end. An aboveground 24 inch sanitary sewer supported by concrete piers passes over the primary spillway through the bridge opening. A 42 inch below ground sanitary sewer passes through the west abutment.

Dam Break Scenario

The dam break analysis and inundation mapping of College Lake Dam were completed by Black & Veatch for the City of Lynchburg, and are contained in the May 2019 EAP of the dam. Figure 4-87 provides an overview of the inundation zone and the location of vulnerable facilities within the zone.

Vulnerable Structures

During a dam breach event, several major roadways may be impacted. CSX Transportation railroad tracks near the south bank of James River and part of Norfolk Southern Railroad may be flooded. Lakeside Drive would be closed from Old Forest Road to Moorman Drive. Highways and local main arteries like Langhorne Rd (Route 501), 5th Street (Route 163), Rivermont Avenue (Route 501A), *etc*. would be impacted (Figure 4-88). In addition, the following roads would be blocked if the dam breaks.

- 20 block 7th St
- 20 block 9th St
- 3000 block Birchwood Dr
- 20-40 block Cabell St

- 0-20 block Clifton St
- 100 block Halsey Rd
- 2300 block Heronhill Pl
- 2800 block Hill St
- 3200 block Hill St
- 1900 block Hillsdale Rd
- 100-500 block Hillside Ct
- 700 block Jefferson St
- 2800 block Kulman Pl
- 2200 block Oriole Pl
- 200-300 block Peninsular St
- 100-200 block Stonewall St
- 1900 block Thomson Dr

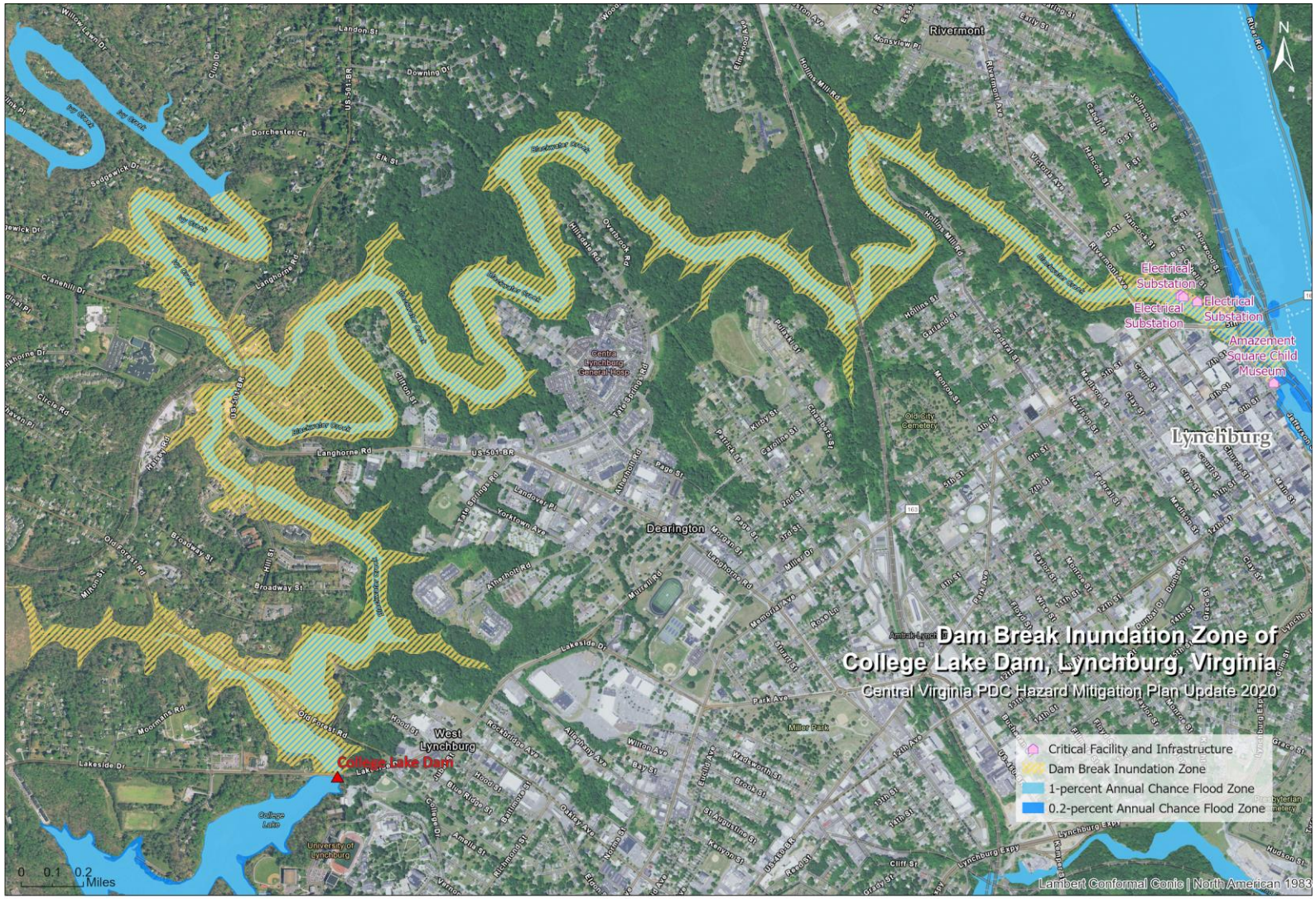
There are also several vulnerable road bridges and the Amazement Square Children's Museum are located in the dam breach zone of College Lake Dam (Table 4-105 and Table 4-106).

Table 4-105 Vulnerable road bridges in dam breach scenario of College Lake Dam

Road Name	Crossing	Bridge Location	Lon	Lat	In flood zone
Cranehill Drive	Ivy Creek	0.35LINKHORN/0.01LANGHORN	-79.19012	37.41823	No
Hill Street	Blackwater Creek	0025BDWAY ST 0009LGHE RD	-79.18784	37.41218	1%, 0.2%
Hollins Mill Road	Blackwater Creek	.89 RT 501 / .84 RT 29 B	-79.15955	37.42533	1%, 0.2%
Lakeside Drive	Blackwater Creek	0019291 0084WCL LYNC	-79.18393	37.40163	0.2%
Langhorne Road	Ivy Creek	0.1-Crnhill Dr./0.1-Halsy	-79.18835	37.41675	No
Langhorne Road	Blackwater Creek	.0-Halsey/.14-Kulman	-79.18866	37.41574	No
Old Forest Road	Blackwater Creek	0047221 0125LINKHYDR	-79.18791	37.40524	1%, 0.2%

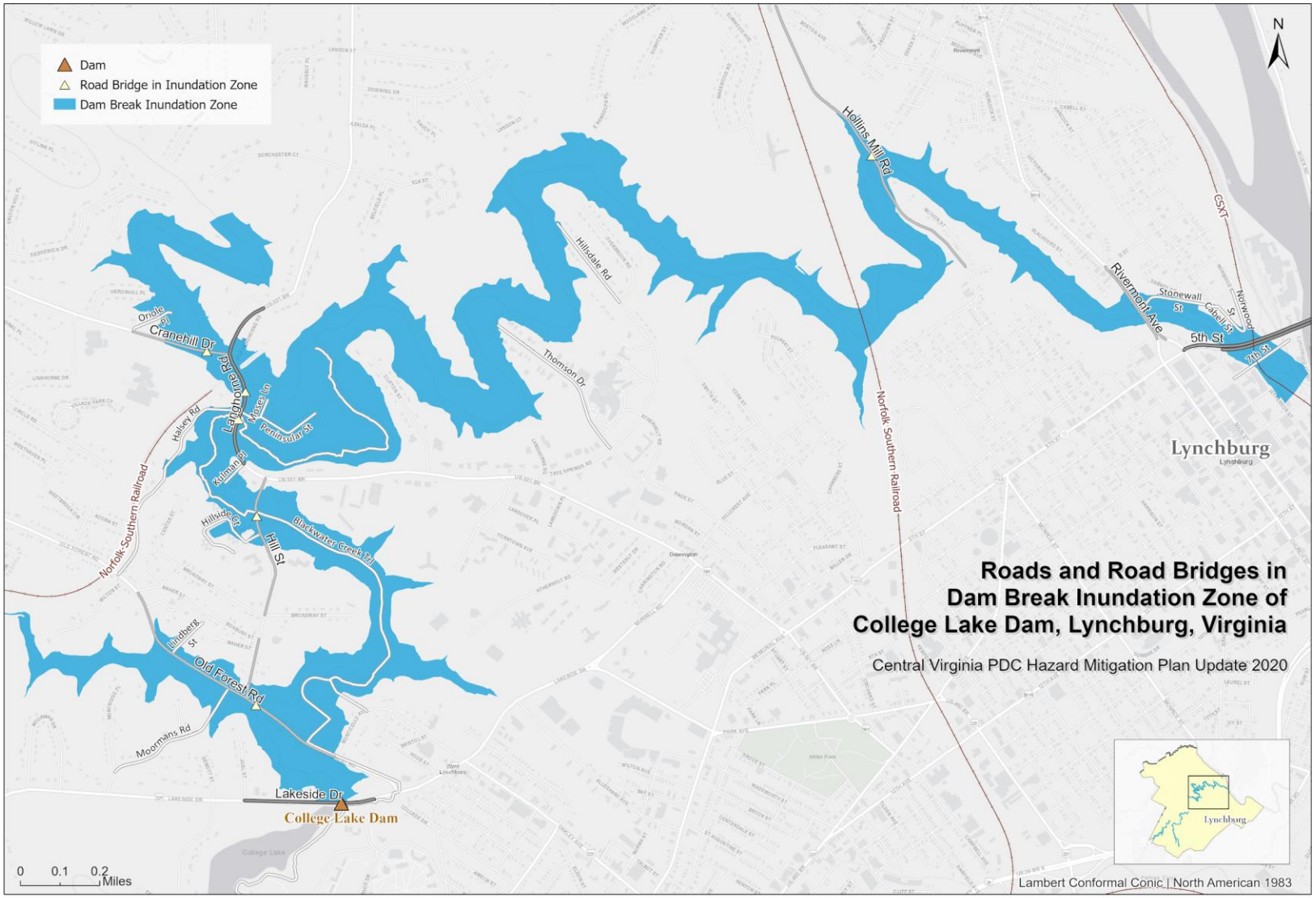
Table 4-106 Vulnerable facilities and infrastructures in dam breach zone of College Lake Dam

Name	Facility Type	Location	Locality	Lon	Lat	In flood zone
Amazement Square Children's Museum	Museum	27 9th St	Lynchburg	-79.1405	37.41619	No



Dam Inundation areas from the City of Lynchburg's Emergency Action Plan showing extents of potential flooding within the City of Lynchburg downstream of local dams. Various flood scenarios with and without dam breaks are depicted. Dam inundation studies were conducted by various Engineering firms for the Dam owners.
Data source: City of Lynchburg GIS Portal, as of 3/14/2018
Center for Geospatial Information Technology at Virginia Tech. 04/2020

Figure 4-87 Dam Break Inundation Zone of College Lake Dam



Dam Inundation areas from the City of Lynchburg's Emergency Action Plan showing extents of potential flooding within the City of Lynchburg downstream of local dams. Various flood scenarios with and without dam breaks are depicted. Dam inundation studies were conducted by various Engineering firms for the Dam owners.
Data source: City of Lynchburg GIS Portal, as of 3/14/2018; VGIN RCL 2019Q4; US DOT National Bridge Inventory | Center for Geospatial Information Technology at Virginia Tech. 04/2020

Figure 4-88 Vulnerable Roads and Road Bridges in Dam Break Inundation Zone of College Lake Dam

Economic Losses analysis

Flood scenarios inundation study of high hazard dams are as follows:

- PMF with dam break
- PMF without dam break
- 90 Percent PMF with dam break
- 90 Percent PMF without dam break
- 20 percent PMF with dam break
- 20 Percent PMF without dam break
- Sunny day

Using Hazus, a PMF with dam break scenario was used to estimate a failure of the College Lake Dam. The PMF is the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the drainage basin under study.

A flood depth grid for the College Lake Dam failure scenario was prepared using ⅓ arc second (approximately 10 meters or 33 feet) DEM and the College Lake Dam failure scenario inundation area (Lynchburg Open Data portal).[33] The dam inundation area boundary is taken from the City of Lynchburg's EAP and shows the extent of potential flooding within the City downstream of local dams. Various flood scenarios with and without dam breaks are depicted in the plan.

Hazus level 2 analysis was conducted for the above scenario to estimate the direct losses from a dam breach. The Hazus default depth damage functions were replaced by higher loss depth damage functions found in the Hazus library. Detailed building level information required to run a level two analysis was combined from various sources. More information about the methodology and datasets can be found within the flooding hazard data section as well as the appendices. The direct economic loss estimates are provided in Table 4-107 and Table 4-108. Figure 4-89 displays the buildings that will be damaged from this scenario based on the losses incurred in the City of Lynchburg.

Table 4-107 Direct Economic Losses for Impacted Facilities (College Lake Dam Breach Scenario)

Capital Stock Exposure		Capital Stock Losses				Loss Ratio	
Building Exposure ($K)	Contents Exposure ($K)	Building Loss ($K)	Contents Loss ($K)	Inventory Loss ($K)	Total Loss ($K)	Buildings %	Contents %
93,880.56	71,080.75	47,320.33	55,223.03	1,346.43	103,889.79	56.2	77.9

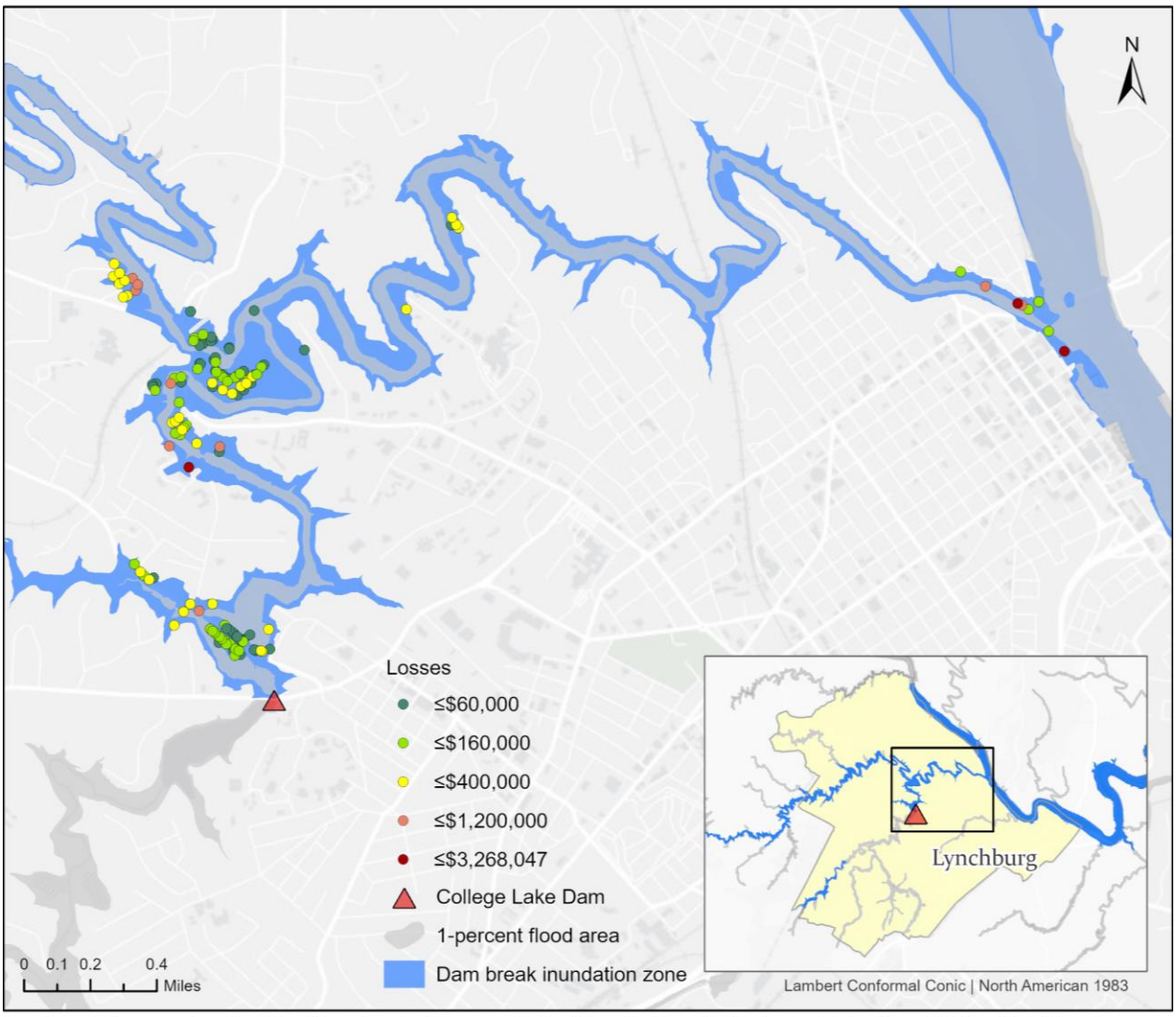
Table 4-108 Direct Economic Losses by Building Occupancy (College Lake Dam Breach Scenario)

Locality	Residential ($K)	Commercial ($K)	Industrial ($K)	Government ($K)	Religion ($K)	Education ($K)
Total Loss ($K)	37,233.02	56,252.96	7,362.67	0	731.36	963.35

[33] http://data-cityoflynchburg.opendata.arcgis.com/datasets/dam-inundation

Building Losses from College Lake Dam Break Inundation in Central Virginia PDC

Central Virginia PDC Hazard Mitigation Plan Update 2020



Dam Inundation areas from the City of Lynchburg's Emergency Action Plan showing extents of potential flooding within the City of Lynchburg downstream of local dams. Various flood scenarios with and without dam breaks are depicted. Dam inundation studies were conducted by various Engineering firms for the Dam owners.

Data source: City of Lynchburg GIS Portal, as of 3/14/2018; HAZUS-Level 2 Analysis
Center for Geospatial Information Technology at Virginia Tech. 08/2019

Figure 4-89 Building Losses from College Lake Dam Break Inundation (Hazus-Level 2 Analysis)

4.4.4 Probability of Future Occurrences

Predicting the probability of flooding due to dam failure requires a detailed, site-specific engineering analysis for each dam in question. Failure may result from hydrologic and hydraulic design limitations, or from geotechnical or operational factors. The data and time necessary to perform a probabilistic failure analysis for each dam in the region is beyond the scope of this plan.

4.4.5 References

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