SECTION 6A – HIGH HAZARD POTENTIAL DAMS

Sections 4, 5, and 6 of this Plan update discuss dam/levee failures in general. This section will look at High Hazard Potential Dams in particular.

Introduction

Dam failures are most likely to happen for one of five reasons: overtopping, foundation defects, cracking, inadequate maintenance and upkeep, and piping. 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.

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 wall. No matter the cause, the aftermath of such an event can range from moderate to severe. The failure of a major dam - defined as a high and/or significant hazard dam – could 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.

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.

According to data from the Association of State Dam Safety Officials, between 2010 and 2022, there were nine (9) instances of dam failure in Virginia. The breakdown of causes is shown in Table 6a-1.

Table 6a-1 – Causes of Dam Failure in Virginia, 2010 – 2022

Incident Driver	Number
Deterioration or Poor Condition	5
Seepage/internal Erosion	2
Structural Stability	1
Unknown	1

Incident Mechanism	Number
Spillway Pipe Failure	3
Piping	2
Erosion	2
Cracking	1
Unknown	1

Source: Association of State Dam Safety Officials

According to the Virginia Department of Conservation and Recreation's (DCR) Dam Safety and Floodplain Management Division (DSFPM), dams are classified as follows:

- *High* - dams that upon failure would cause probable loss of life or serious economic damage.
- *Significant* - dams that upon failure might cause loss of life or appreciable economic damage.
- *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 economic damage only to property of the dam owner.

Source: https://www.dcr.virginia.gov/dam-safety-and-floodplains/damclass

Coordination, Reporting Requirements

In Virginia, some dams are privately owned while others are publicly (locality) owned. All dam owners, whether public or private, are required to coordinate with DCR. Among other things, dam owners are required to submit and update inundation zone mapping and Emergency Actions Plans (EAP) to DCR and update those materials on a regular basis. According to Section 10.1-606.2.A of the Code of Virginia:

> "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). Existing maps prepared by the locality in accordance with these regulations may be used for this purpose."

Section 10.1-606.2.B of the Code takes it a step further:

> "All maps prepared in accordance with subsection A shall be filed with the Department of Conservation and Recreation and with the offices with plat and plan approval authority or zoning responsibilities as designated by the locality for each locality in which the dam break inundation zone resides."

Virginia law requires a dam EAP to be updated once every six years at a minimum, but it should be updated any time the owner is aware of changes. This is covered in Section 4VAC50-20-175 of the Virginia Administrative Code, paragraphs A through D:

> "A. In order to protect life during potential emergency conditions at an impounding structure, and to ensure effective, timely action is taken should an impounding structure emergency occur, an EAP shall be required for each High and Significant Hazard Potential impounding structure. The EAP shall be coordinated with the Department of Emergency Management in accordance with § 44-146.18 of the Code of Virginia. The EAP required by these regulations shall be incorporated into local and interjurisdictional emergency plans pursuant to § 44-146.19 of the Code of Virginia.

B. It is the impounding structure owner's responsibility to develop, maintain, exercise, and implement a site-specific EAP.

C. An EAP shall be submitted every six years. The EAP shall be submitted with the owner's submittal of their Regular Operation and Maintenance Certificate application (Operation and Maintenance Certificate Application for Virginia Regulated Impounding Structures).

NOTE: Digitized EAPs are maintained in DCR's Electronic Dam Safety Inventory System (DSIS). Paper-based copies are also sent to VDEM's Situational Awareness Unit, located in North Chesterfield, Virginia.

D. The owner shall update and resubmit the EAP immediately upon becoming aware of necessary changes to keep the EAP workable. Should an impounding structure be reclassified, an EAP in accordance with this section shall be submitted."

Paragraphs E and F of the Virginia Administrative Code, Section 4VAC50-20-175, cover testing and exercise requirements for dams:

"E. A drill shall be conducted annually for each high or significant hazard impounding structure. To the extent practicable, the drill should include a face-to-face meeting with the local emergency management agencies responsible for any necessary evacuations to review the EAP and ensure the local emergency management agencies understand the actions required during an emergency. Except as set out in 4VAC50-20-53, a table-top exercise shall be conducted once every six years, although more frequent table-top exercises are encouraged. Drills and table-top exercises for multiple impounding structures may be performed in combination if the involved parties are the same. Owners shall certify to the department annually that a drill, a table-top exercise, or both has been completed and provide any revisions or updates to the EAP or a statement that no revisions or updates are needed.

F. Impounding structure owners shall test existing monitoring, sensing, and warning equipment at remote or unattended impounding structures at least twice per year or as performed by the Virginia Department of Emergency Management pursuant to § 10.1-609.1 of the Code of Virginia and maintain a record of such tests."

DCR, VDEM, and local emergency and planning staff are provided copies of approved EAPs for covered dams. The plans include detailed information on risk to the following:

- Dwellings;
- Schools;
- Hospitals;
- Businesses;
- Railroads;
- Utilities;
- Parks;
- Golf Courses;
- Public Trails; and
- Emergency Infrastructure.

Professional Engineers (PEs) analyze the risk at each dam by evaluating growth downstream of the dam during each inspection and in detail every six years during the EAP update. In the case of dams in series, PEs must evaluate the most critical combination. Other factors considered in the risk assessment by DSFPM include the population at risk, land use, inspection condition assessment any missing studies (such as stability analyses under normal and extreme loading conditions, seismic and hydrologic), and any measures underway that affect the operational status (such as drawdowns or temporary pumps and siphons when dams are compromised). DSFPM is moving toward the development of more comprehensive evacuation plans in future EAPs that incorporate information about blocked roads and provide the best escape routes.

The owner and PE must regularly monitor development upstream of the dam and update the dam break inundation zone unless the dam was designed for full future upstream development. If upstream changes in development necessitate a new spillway design flood exceeding the existing spillway capacity, an alteration permit and subsequent construction of spillway modifications is required. Currently, DSFPM requires PEs to map each structure and, for those that could affect businesses, residences, schools or other occupied structures, compute both the arrival time of the flood wave and time and magnitude of peak flood. Population at Risk (PAR) data for dwellings is calculated using data from the U.S. Census Bureau. Coordination between DCR and local dam owners has been identified as an area where improvement is needed. The CRC plans to work on addressing this through the one of the new mitigation actions listed below: Conducting annual in-person education and outreach with local emergency managers, SWCD's, dam owners re: dam safety, reporting, testing.

Overview of Vulnerability

According to the Commonwealth of Virginia Hazard Mitigation Plan, citing data from DSFPM, there are 38 High Hazard Potential Dams (HHPD) located in Planning District 14. They are listed in Table 6a-2. Risks and vulnerabilities to and from HHPDs include:

- Potential significant economic, environmental, or social impacts as well as multijurisdictional impacts from a dam incident;
- Loss of services such as flood control, water supply, water quality, wildlife, or recreation when the dam fails;
- Disruptions to the transportation network; and
- Damage to critical infrastructure.

The risk and vulnerability assessment for this Plan was based on the risk and vulnerability assessment found in the Commonwealth of Virgina Hazard Mitigation Plan (CVHMP), March 2023. For a detailed description, see the section in the CVHMP regarding impoundment failures.

Table 6a-2 – HHP Dams in Planning District 14

Dam Name	County	Condition Assessment	Structure Impacts	Primary Road Impacts	Est. PAR
Bridgeforth Mill Dam 1	Amelia	Satisfactory	1	1	6
Willis River Dam #1A	Buckingham	Satisfactory	10	2	22
Willis River Dam #3	Buckingham	Satisfactory	1	2	9
Willis River Dam #4	Buckingham	Satisfactory	1	1	6
Willis River Dam #5E	Buckingham	Satisfactory	1	1	24
Willis River Dam #5F	Buckingham	Fair	1	1	13
Willis River Dam #6	Buckingham	Satisfactory	2	1	16

Willis River Dam #6A	Buckingham	Satisfactory	2	2	16
Willis River Dam #9	Buckingham	Satisfactory	0	3	3
Muddy Creek Dam #1	Buckingham	Fair	4	8	36
Muddy Creek Dam #2	Buckingham	Satisfactory	4	2	17
Slate River Dam #2	Buckingham	Satisfactory	9	3	44
Horsepen Creek Dam	Buckingham	Fair	3	1	7
Willis River Dam #2	Buckingham	Satisfactory	0	3	26
Slate River Dam #8	Buckingham	Satisfactory	8	9	50
Slate River Dam #7	Buckingham	Satisfactory	5	2	43
Buckingham Co. Dam #2	Buckingham	Unsatisfactory	0	1	6
Roanoke Creek Dam # 72A	Charlotte	Satisfactory	45	6	136
Roanoke Creek Dam # 68	Charlotte	Fair	0	3	10
Roanoke Creek Dam # 5B	Charlotte	Fair	1	2	16

Table 6a-2 – HHP Dams in Planning District 14 (cont.)

Dam Name	County	Condition Assessment	Structure Impacts	Primary Road Impacts	Est. PAR
Roanoke Creek Dam # 6A	Charlotte	Fair	0	2	15
Roanoke Creek Dam # 62	Charlotte	Satisfactory	0	1	10
Roanoke Creek Dam # 67	Charlotte	Fair	0	2	6
Roanoke Creek Dam # 4A	Charlotte	Fair	0	1	7
Roanoke Creek Dam # 61A	Charlotte	Satisfactory	0	1	3
Roanoke Creek Dam # 31B	Charlotte	Fair	0	2	12
Roanoke Creek Dam # 54	Charlotte	Fair	0	2	6
Roanoke Creek Dam # 43A	Charlotte	Fair	0	3	10
Cobbs Creek Regional Water Supply Dam (Main Dam A)	Cumberland	Not rated*	2,972	21	7,794
Cobbs Creek Regional Water Supply Reservoir Saddle Dam (Dam B)	Cumberland	Not rated*	2,972	21	7,794
Cobbs Creek Regional Water Supply Reservoir Dam Perimeter Dam (Dam C)	Cumberland	Not rated*	2,972	21	7,794
Nottoway Lake Dam	Nottoway	Fair	0	7	21
Buffalo Creek Dam # 4	Pr. Edward	Satisfactory	34	6	688
Bush River Dam # 2	Pr. Edward	Fair	3	4	21
Bush River Dam # 12	Pr. Edward	Satisfactory	36	28	756
Bush River Dam # 7	Pr. Edward	Fair	1	5	74
Briery Creek Lake Dam	Pr. Edward	Fair	41	10	139
Bush River Dam # 4B	Pr. Edward	Satisfactory	2	5	80

Source: Virginia Dept. of Conservation and Recreation, Dam Safety and Floodplain Management Division
PAR – Population at Risk
*Currently under construction, scheduled for completion in fall 2023

Mitigation Strategies

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." The following mitigation actions were developed for this Plan in consultation with VDEM and DCR staff, and the participating localities:

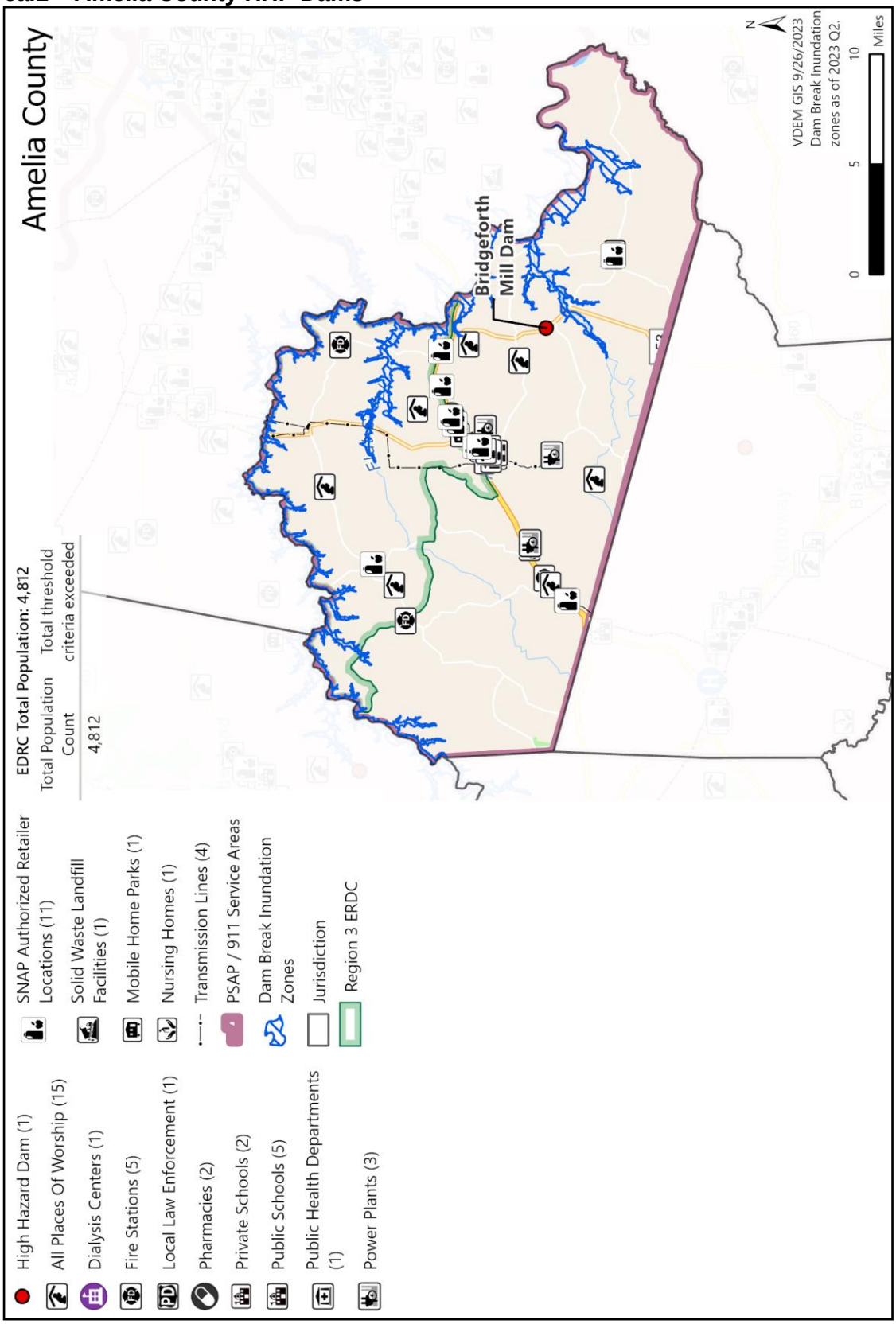
New Mitigation Action	Identify vulnerable dam structures and implement infrastructure retrofit projects, to include measures that reduce risk to existing buildings, utility systems, roads, and bridges
Category	Emergency Services/Property Protection
Hazard(s) Addressed	Flooding, Earthquake, Erosion, Hurricanes, Impoundment Failure, Karst, Landslides, NonTornadic Wind, Wildfires, Winter Weather
Priority	High
Estimated Cost	To be determined based on project needs
Potential Funding Sources	DHS: HMGP, PDM, HHPD, FMA; USACE; Virginia CFPF
Lead Agency/ Department Responsible:	Local governments, SWCDs, DCR, VDEM
Implementation Schedule:	Dependent on availability of funding
Status: Seeking funding to implement	

New Mitigation Action	Conduct annual in-person education and outreach with local emergency managers, SWCD's, dam owners re: dam safety, reporting, testing
Category	Planning
Hazard(s) Addressed	Flooding, Earthquake, Erosion, Hurricanes, Impoundment Failure, Karst, Landslides, NonTornadic Wind, Wildfires, Winter Weather
Priority	High
Estimated Cost	Expected to be minimal, based on staffing needs
Potential Funding Sources	DHS: HMGP, PDM, SHSP, USACE; Virginia CFPF, DCR
Lead Agency/ Department Responsible:	CRC, DCR, VDEM
Implementation Schedule:	During (as part of) annual Plan review process
Status: Targeting start in Summer 2024	

Mapping

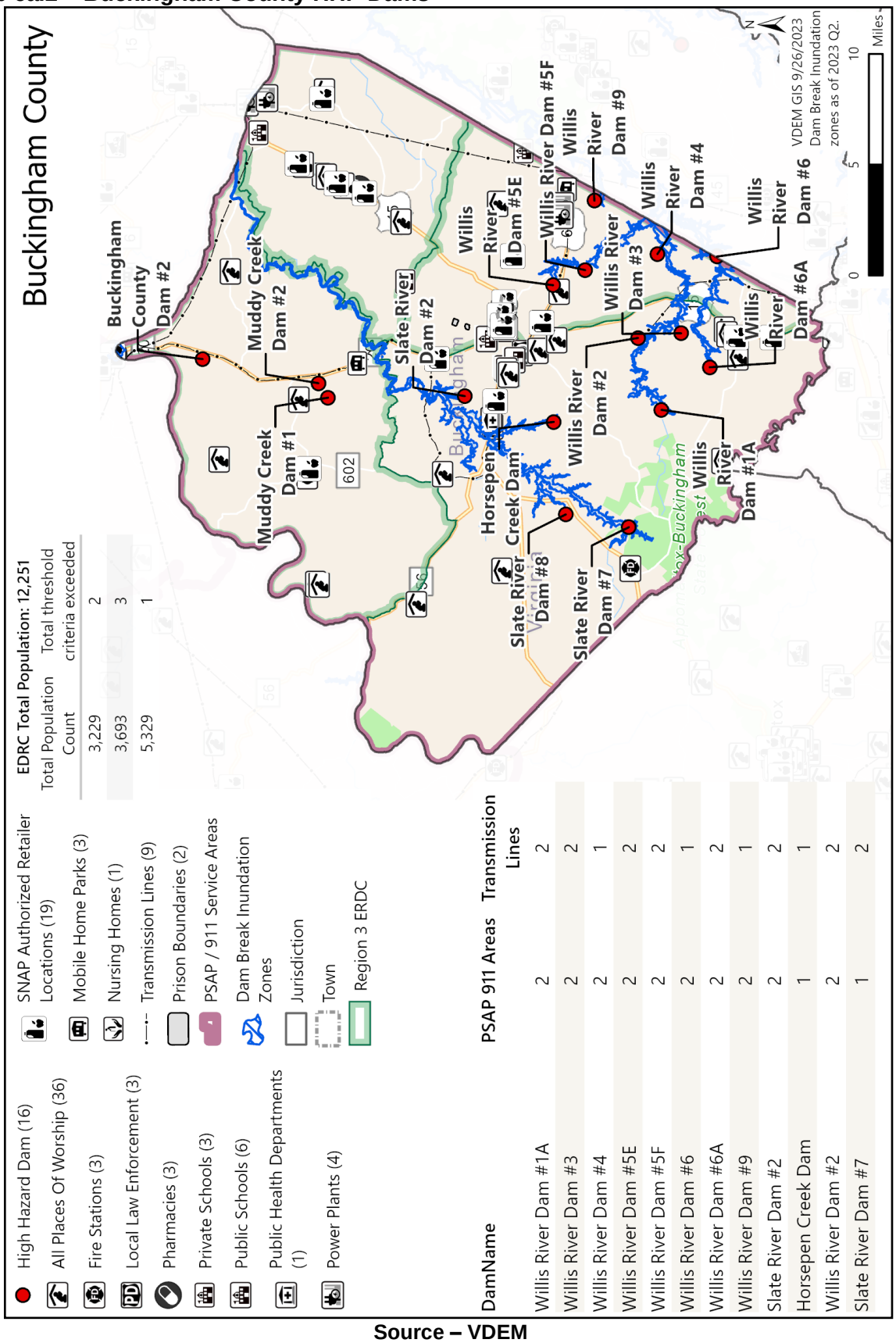
The maps that follow were created by VDEM using publicly available GIS data. These maps include infrastructure and Economically Disadvantaged Rural Communities (EDRC) census tracts and information on the J40 Count for each Census Tract as identified in FEMA's EDRC Dashboard, and each EDRC Census tract's population. The J40 burden count refers to the Climate and Economic Justice Screening Tool which is an interactive map created by a White House initiative that is designed to identify disadvantaged census tracts. If the J40 column is blank for any of the EDRC census tracts, it's because FEMA's EDRC Dashboard lists that census tracts J40 count as unknown.

Map 6a.1 – Ameila County HHP Dams



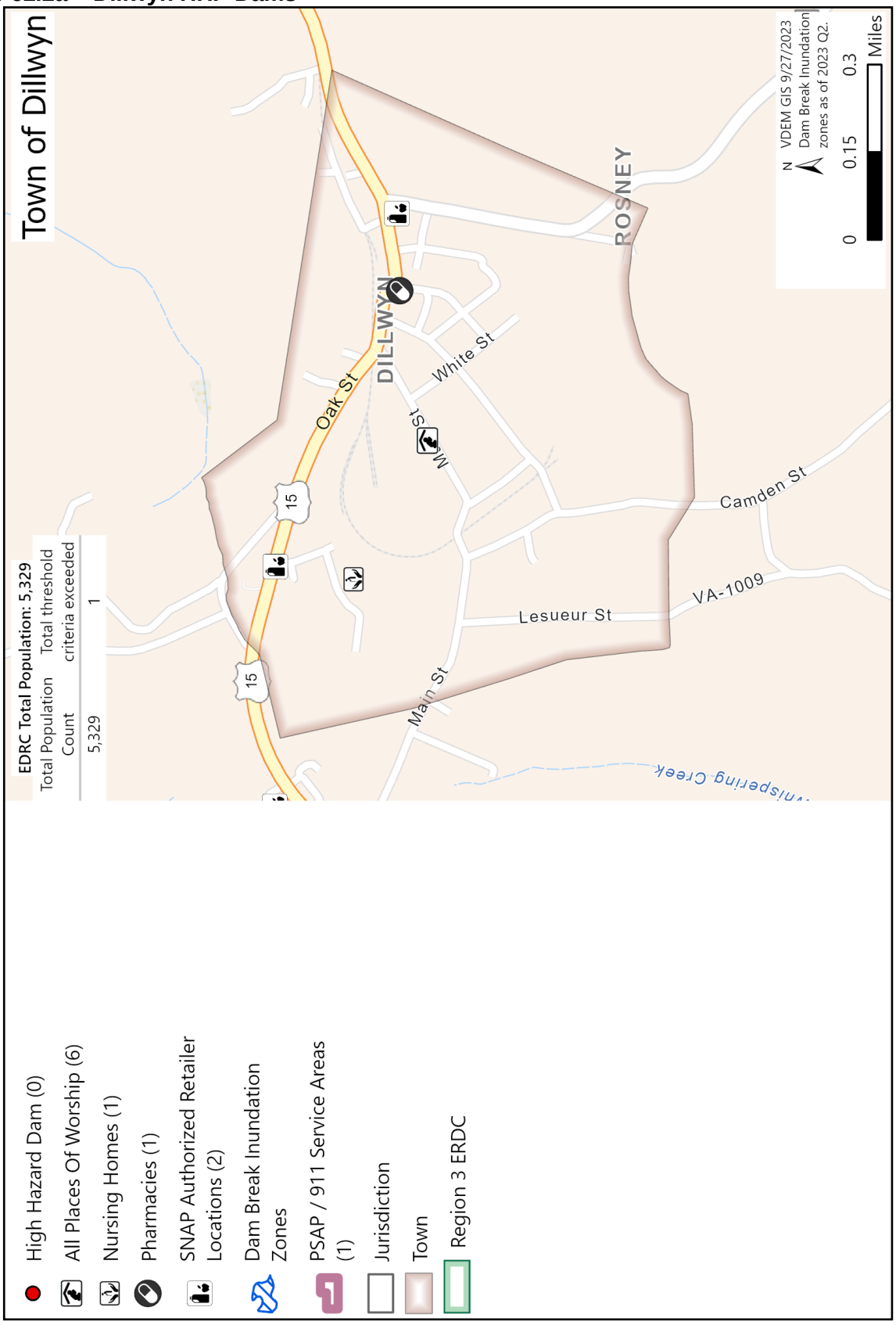
Source – VDEM

Map 6a.2 – Buckingham County HHP Dams



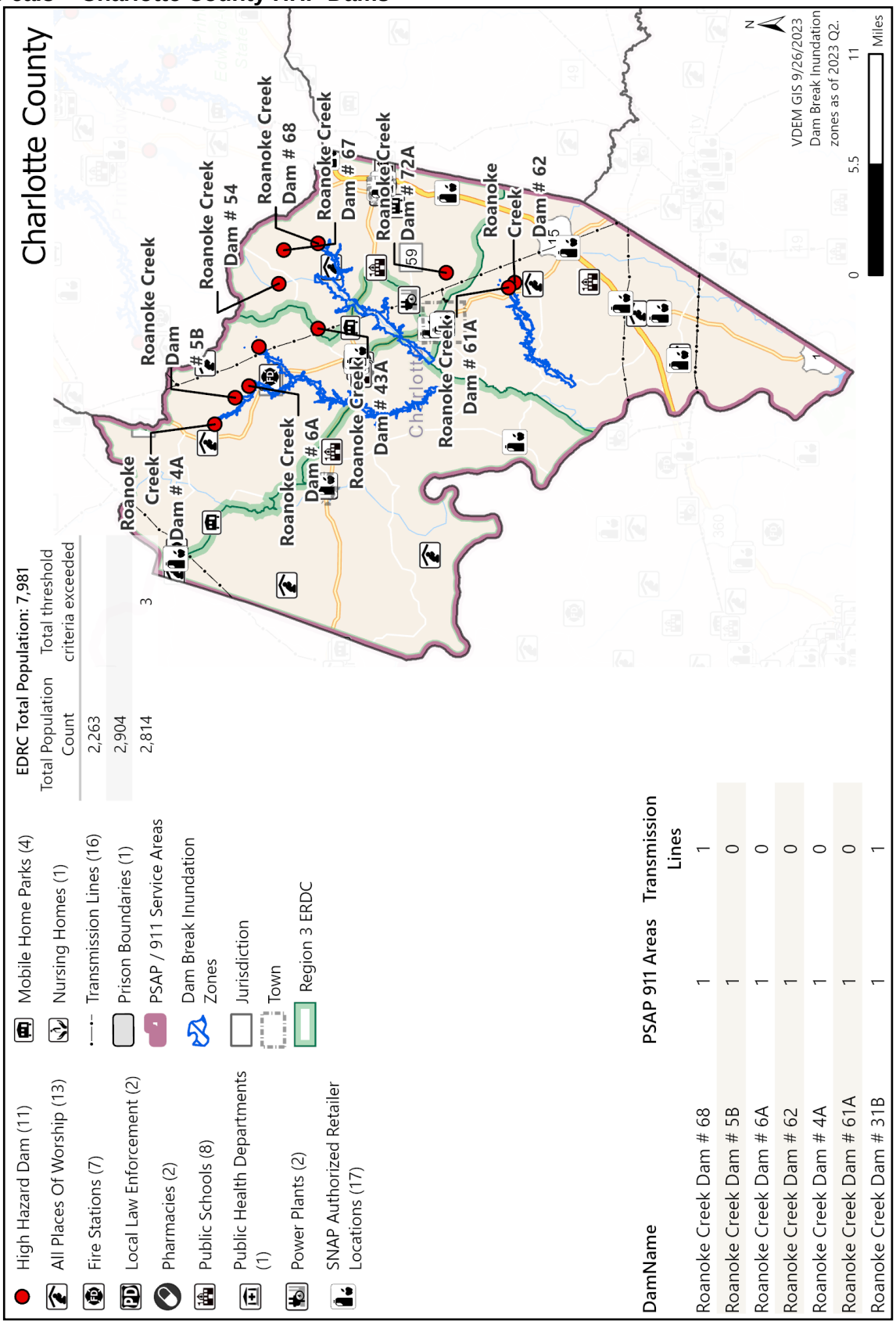
Source – VDEM

Map 62.2a – Dillwyn HHP Dams



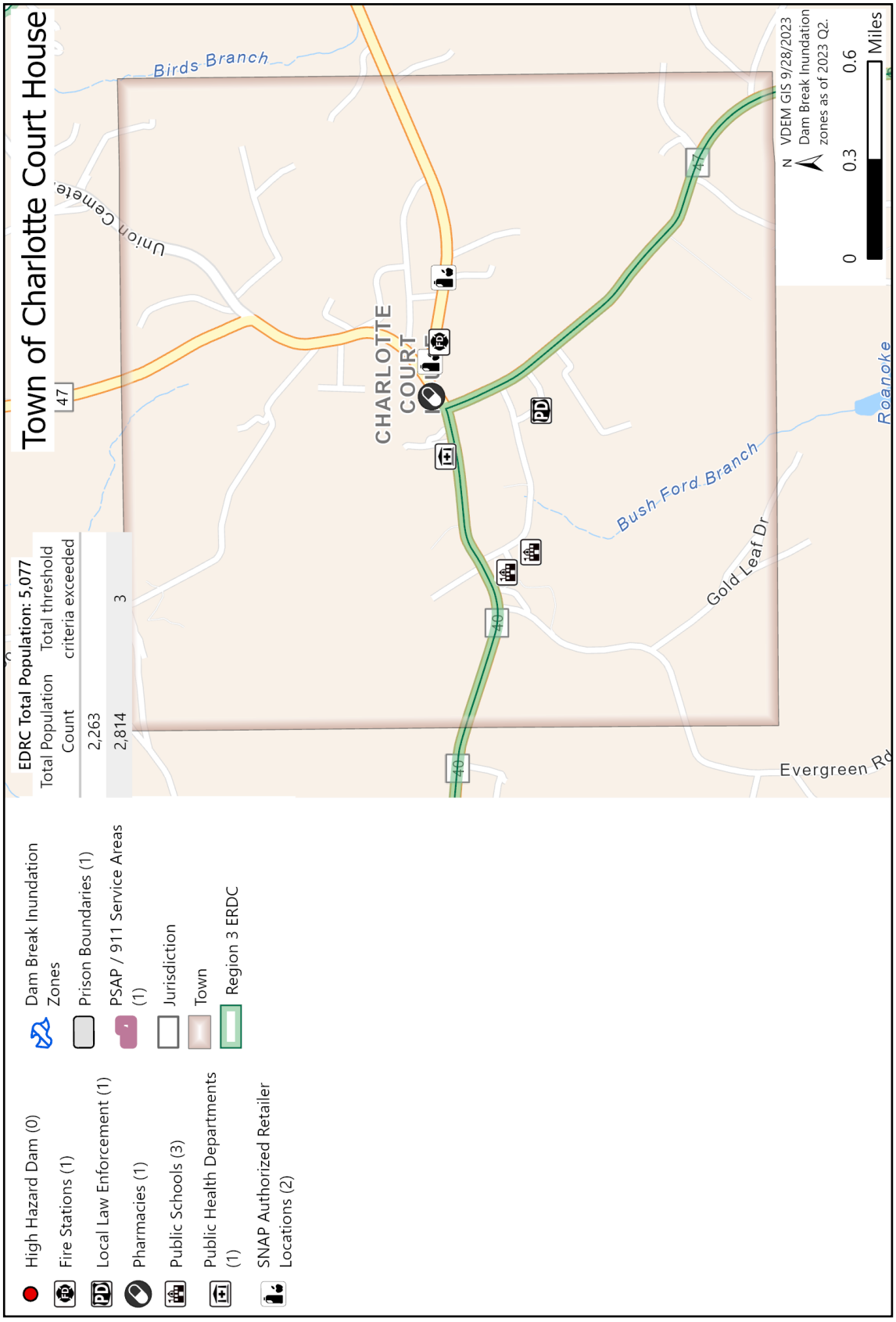
Source – VDEM

Map 6a.3 – Charlotte County HHP Dams



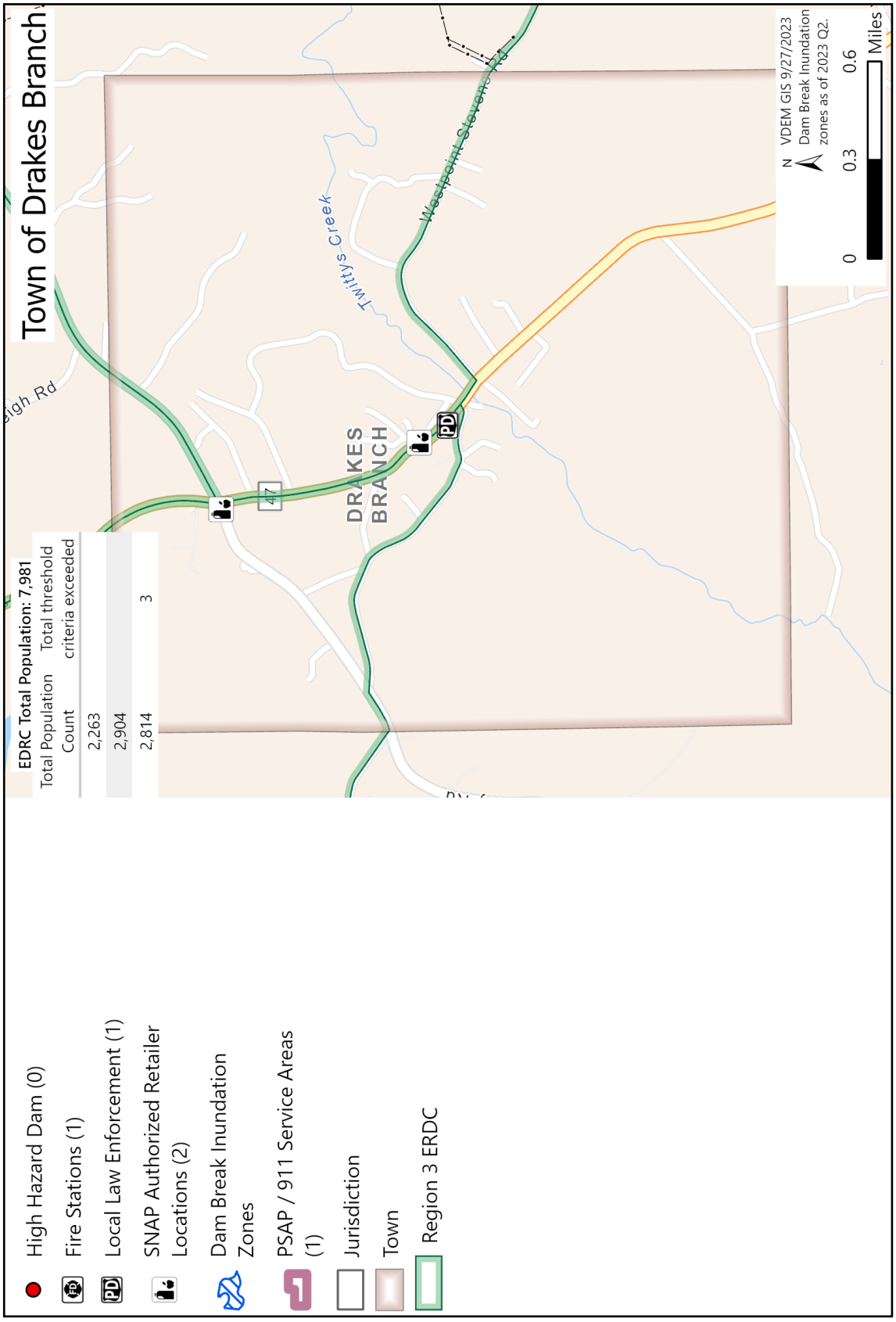
Source – VDEM

Map 6a.3a – Charlotte Court House HHPD dams



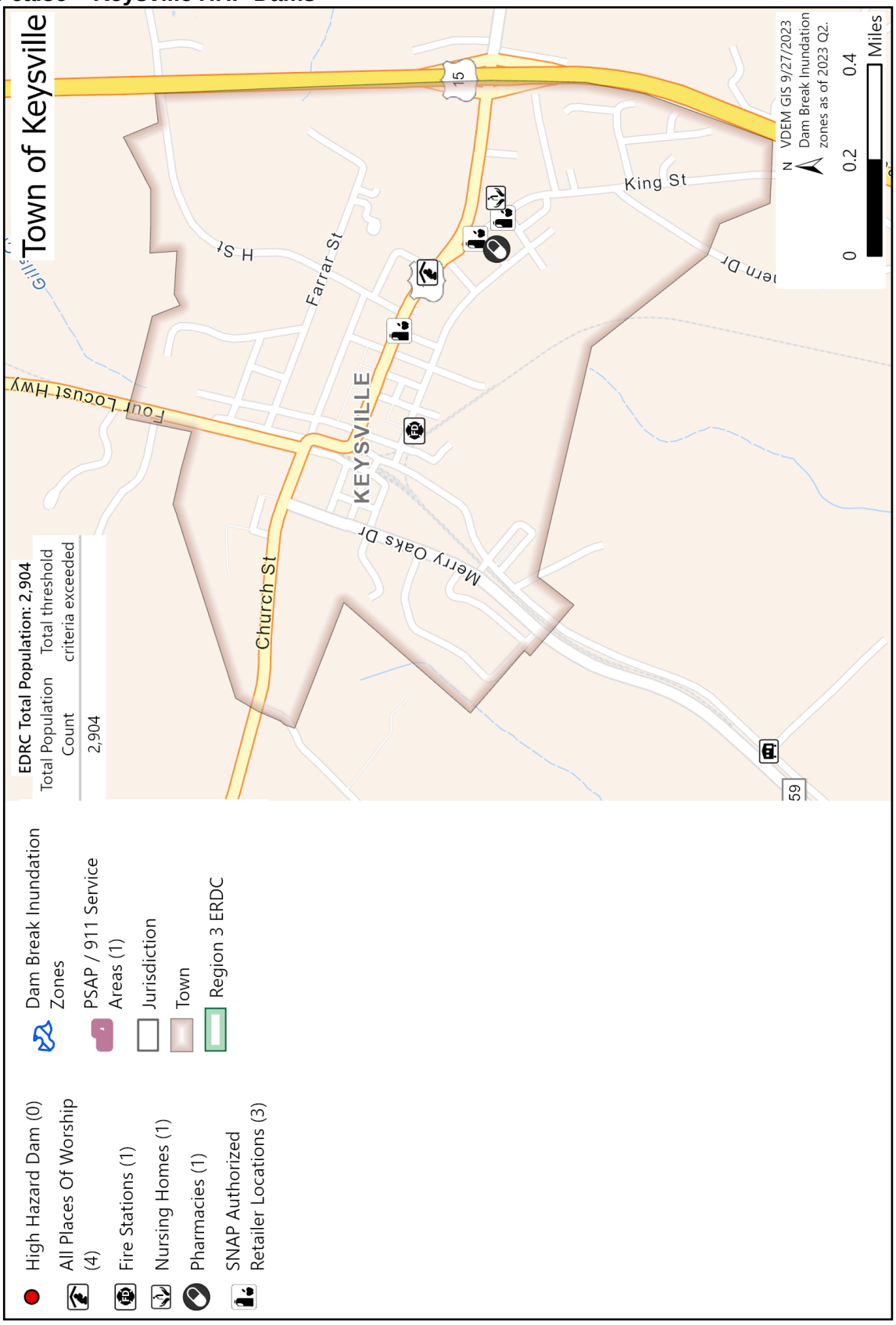
Source – VDEM

Map 6a.3b – Drakes Branch HHP Dams



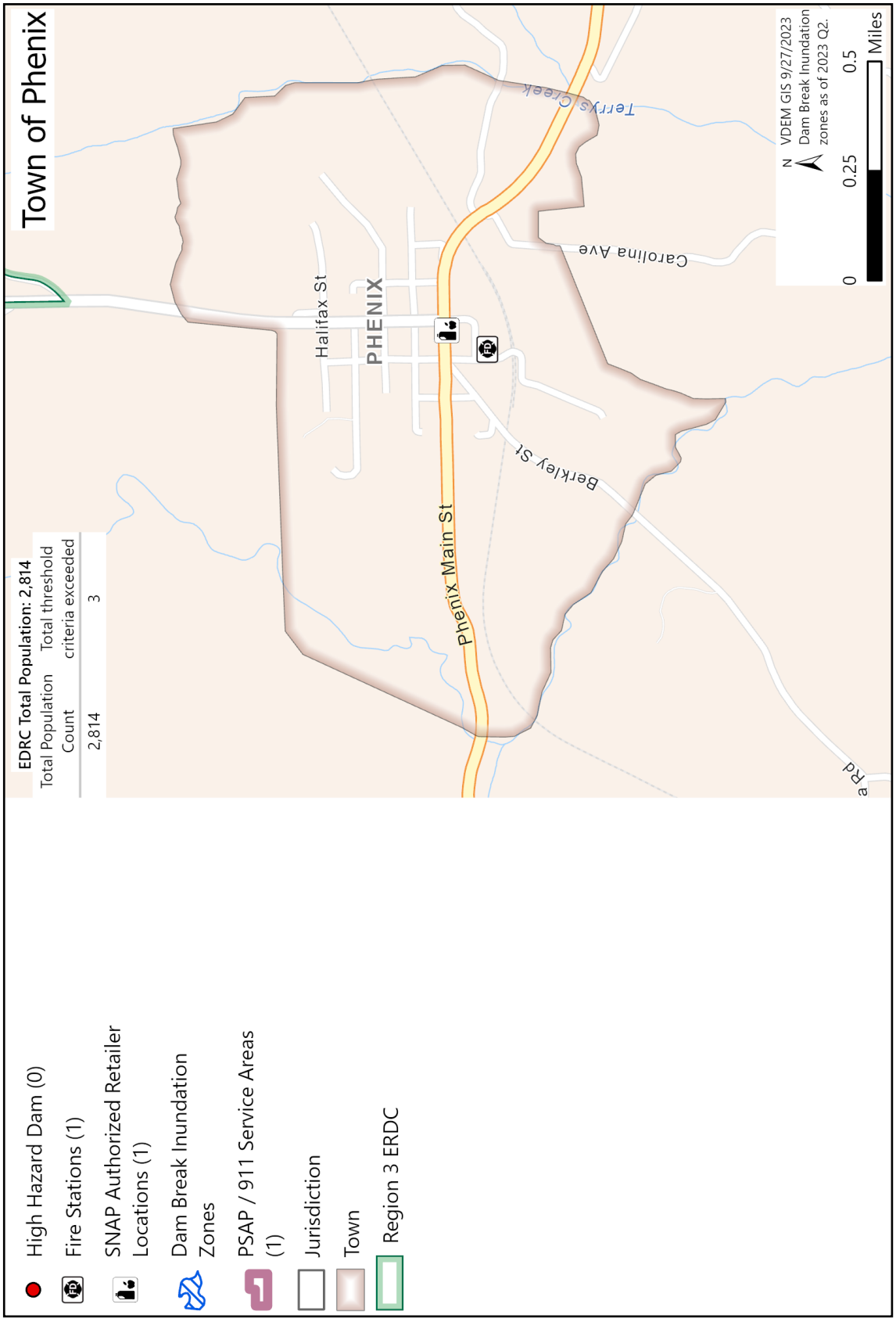
Source – VDEM

Map 6a.3c – Keysville HHP Dams



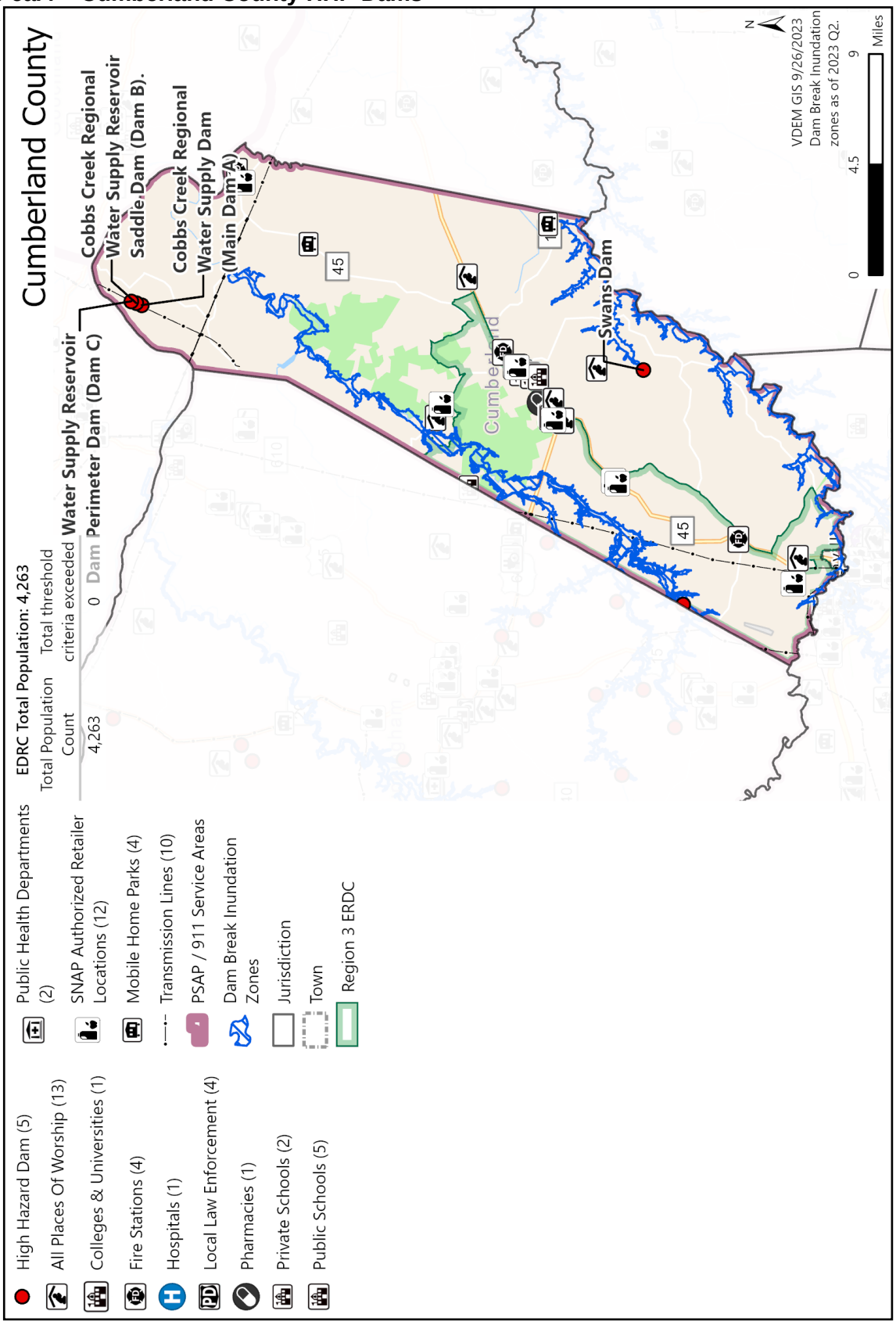
Source – VDEM

Map 6a.3d – Phenix HHP dams



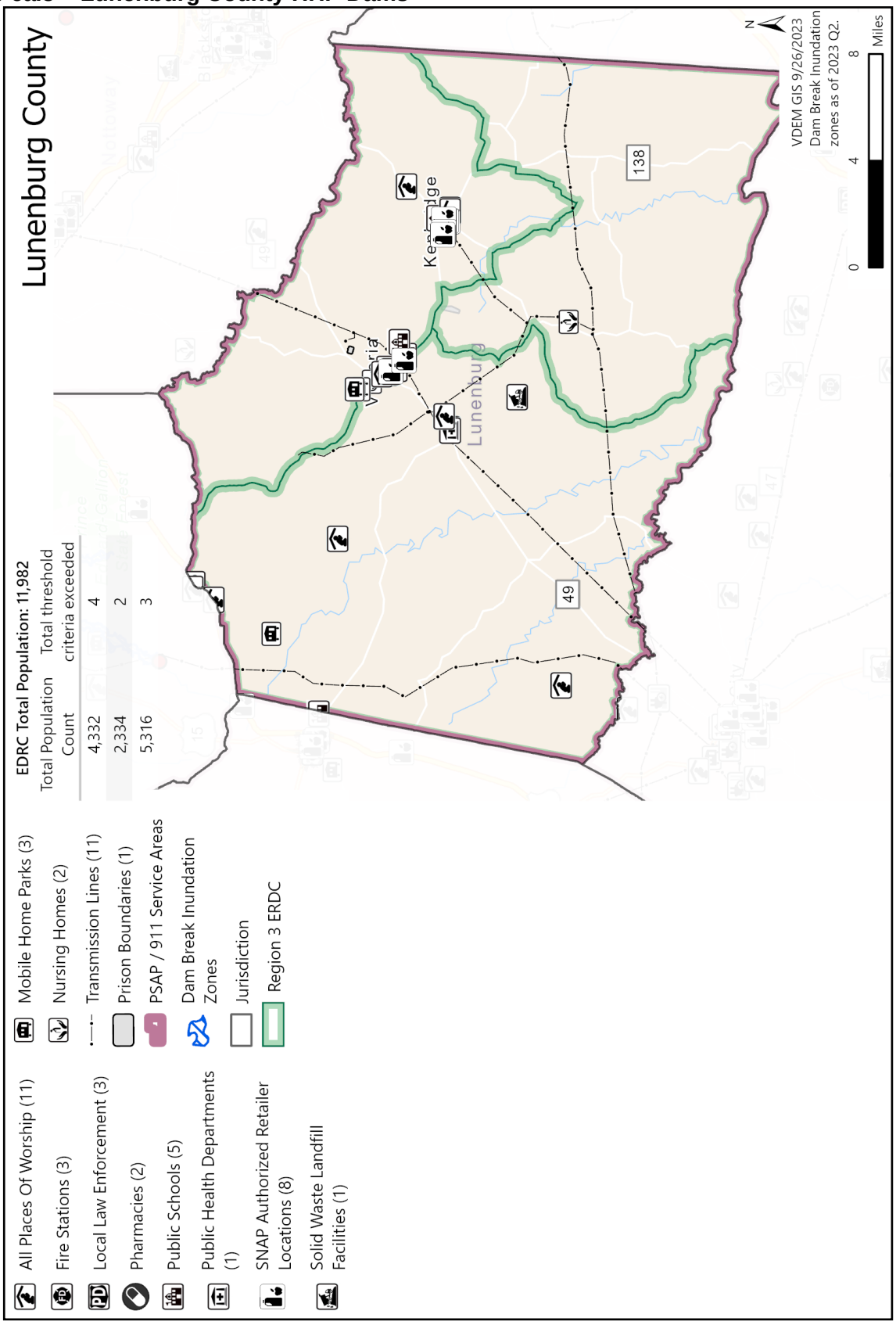
Source – VDEM

Map 6a.4 – Cumberland County HHP Dams



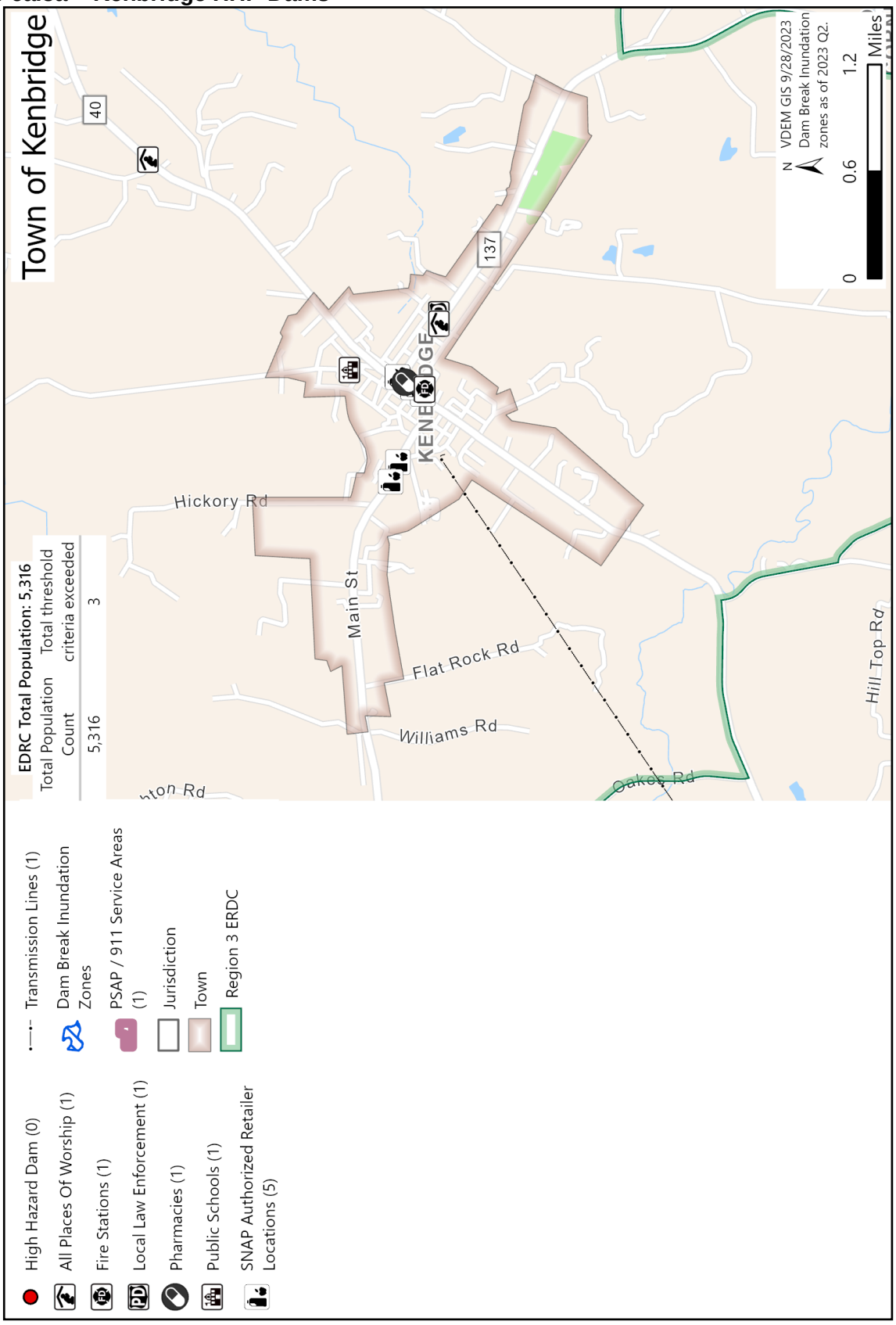
Source – VDEM

Map 6a.5 – Lunenburg County HHP Dams



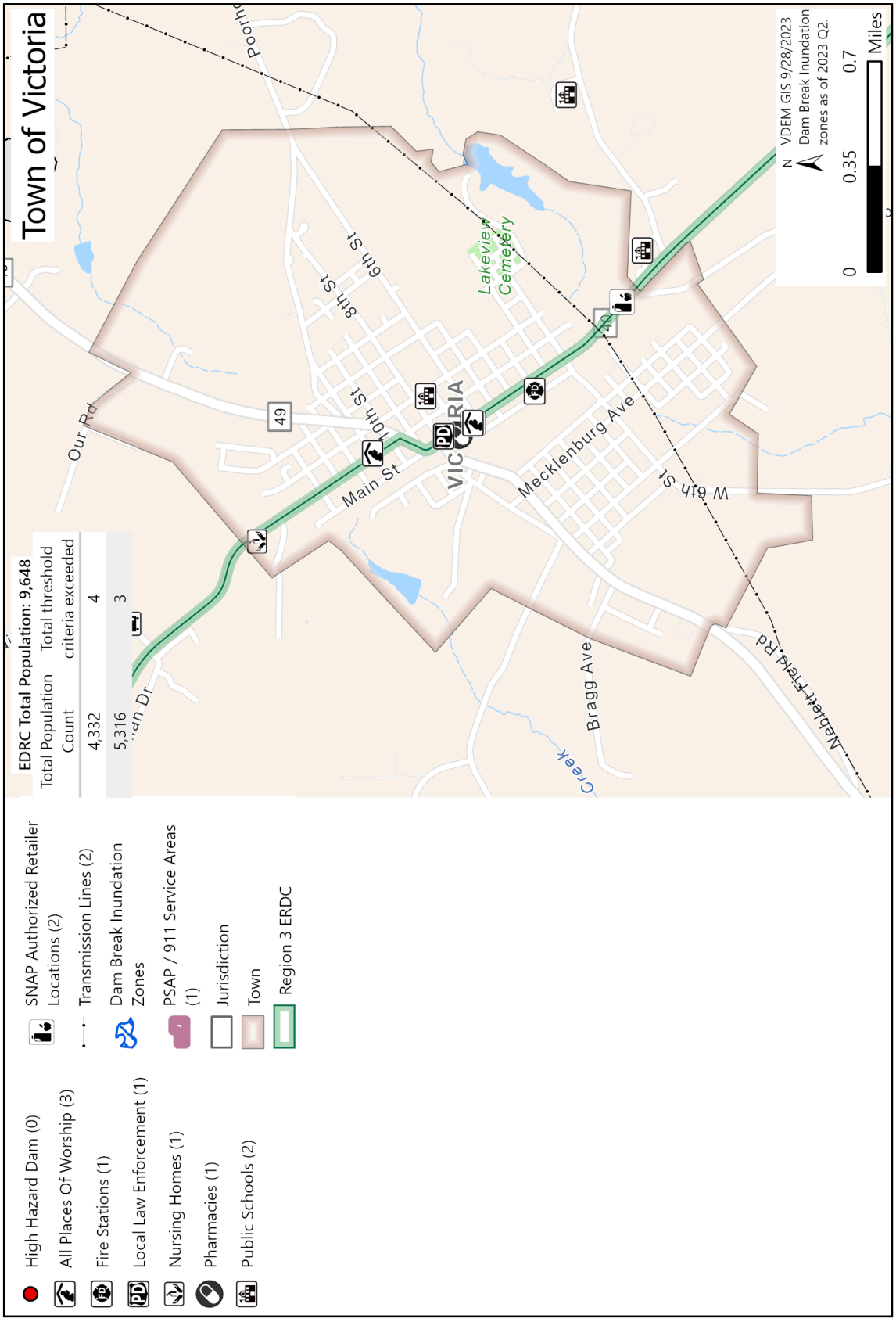
Source – VDEM

Map 6a.5a – Kenbridge HHP Dams



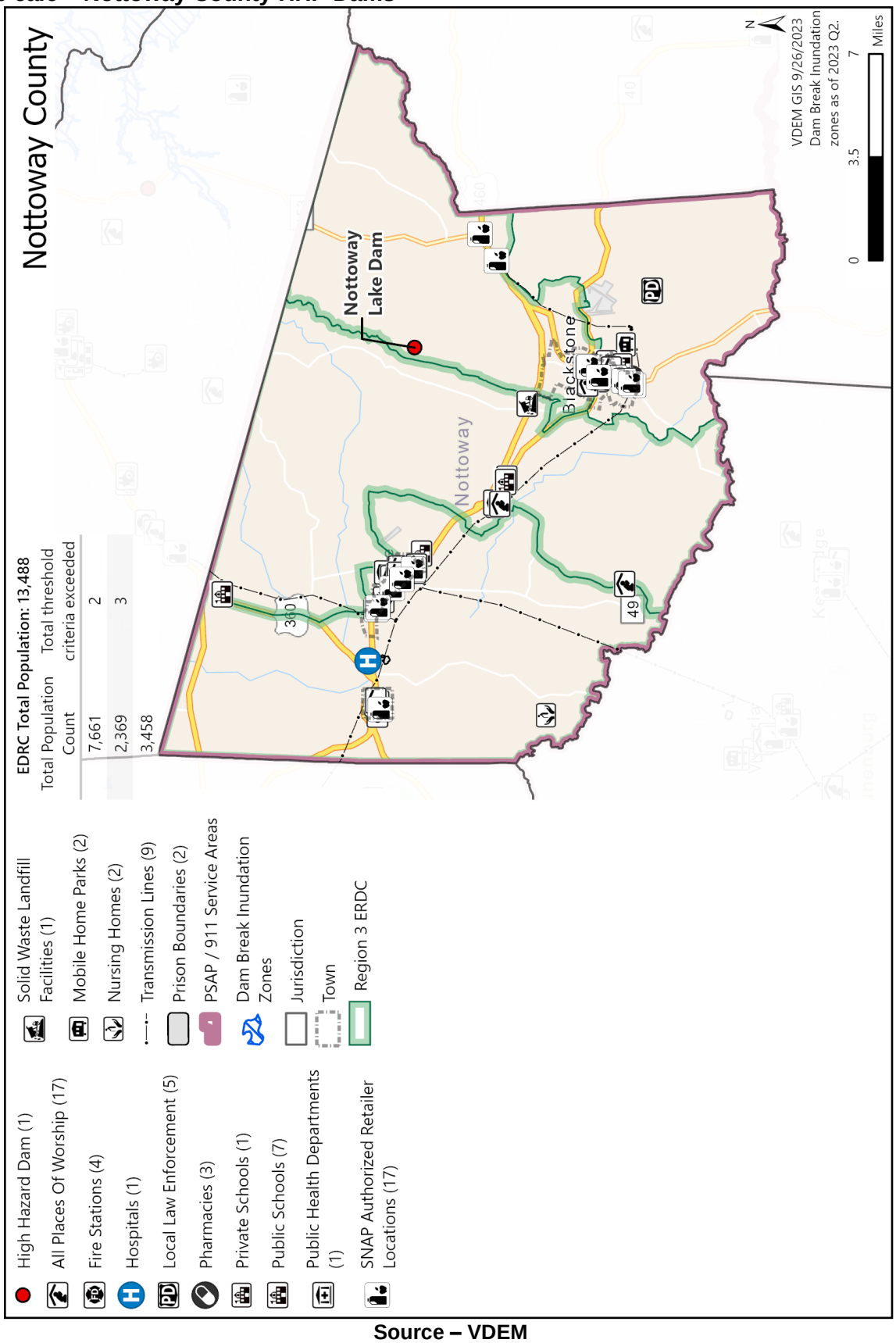
Source – VDEM

Map 6a.5b – Victoria HHP Dams



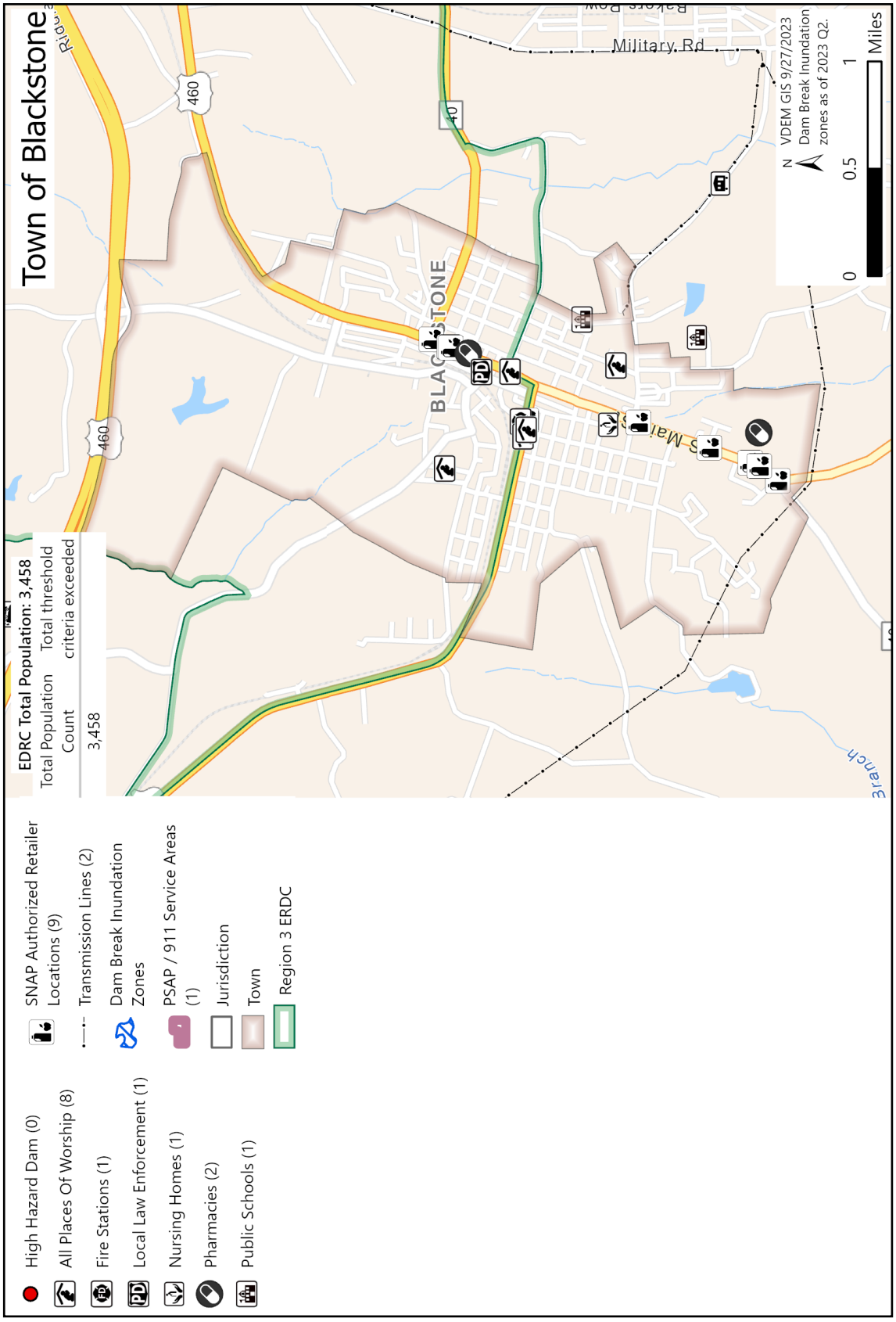
Source – VDEM

Map 6a.6 – Nottoway County HHP Dams



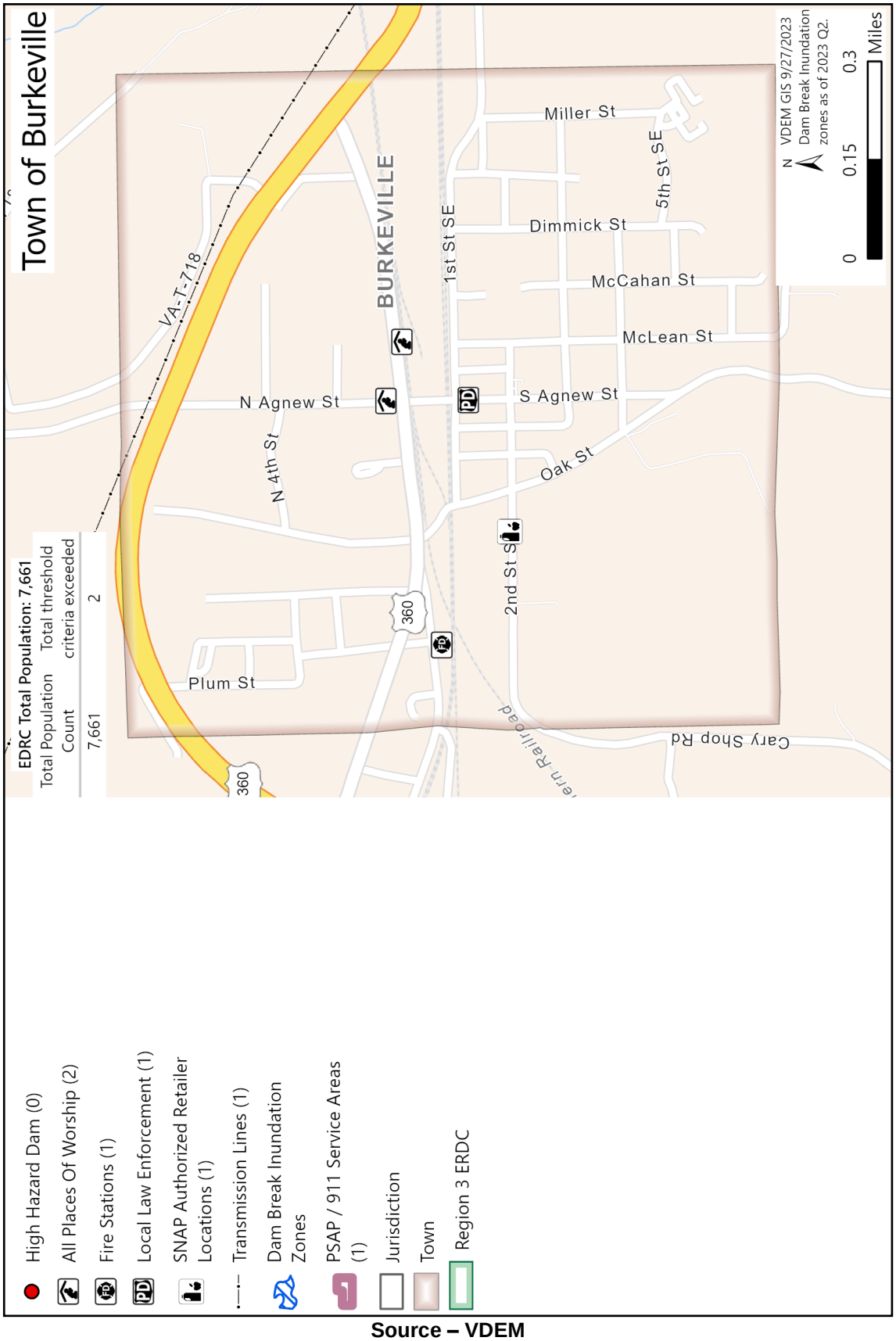
Source – VDEM

Map 6a.6a – Blackstone HHP Dams



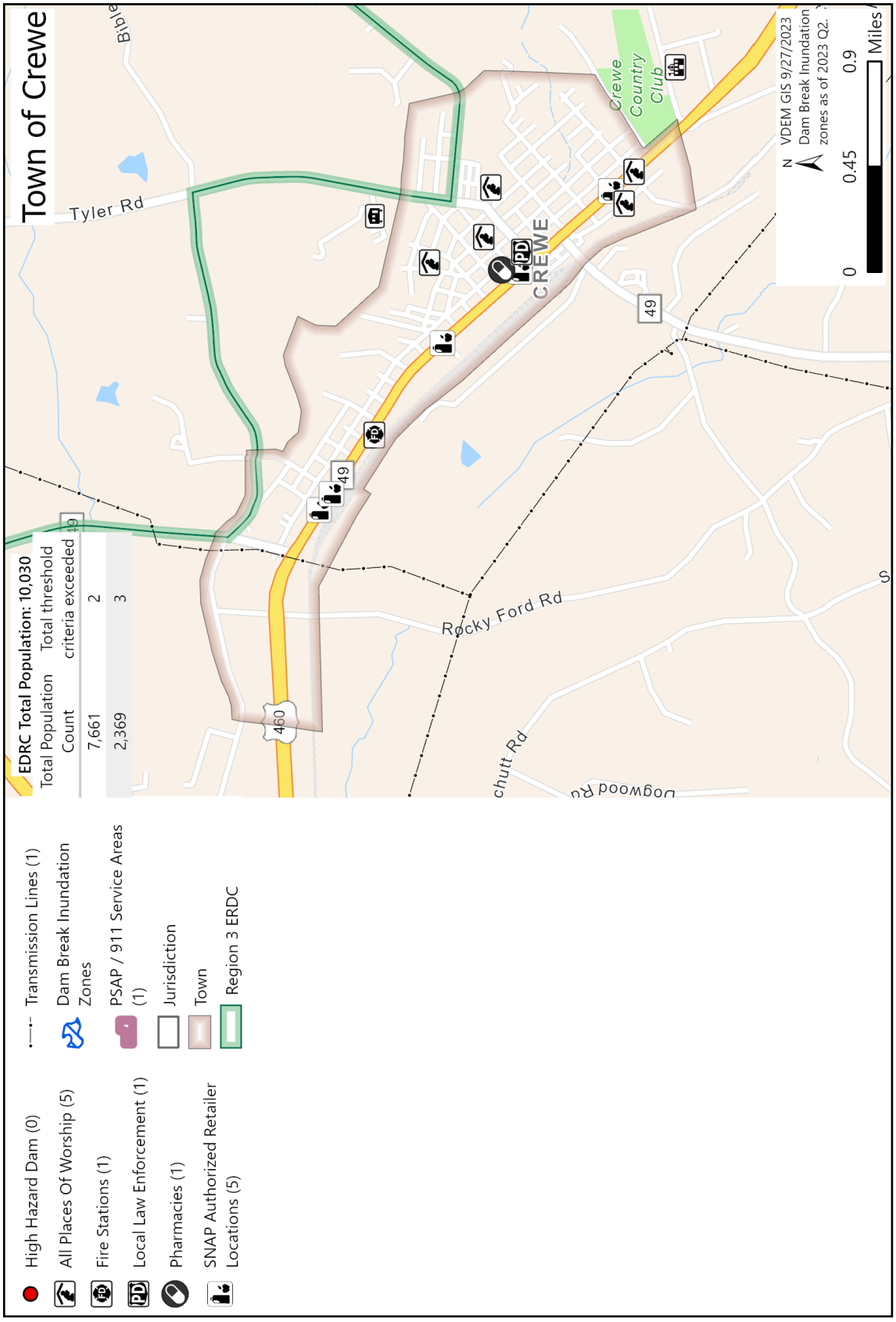
Source – VDEM

Map 6a.6b – Burkeville HHP Dams



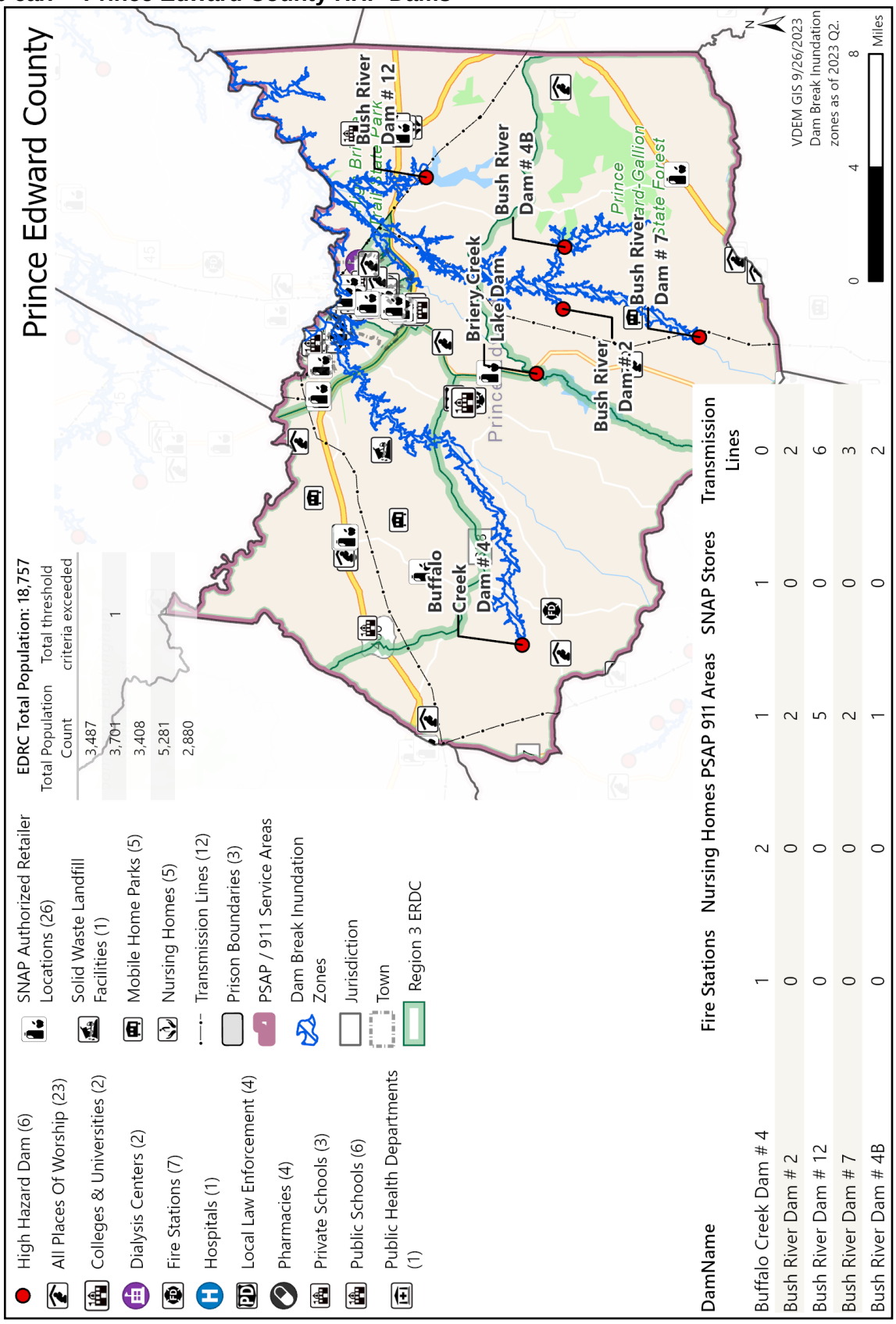
Source – VDEM

Map 6a.6c – Crewe HHP Dams



Source – VDEM

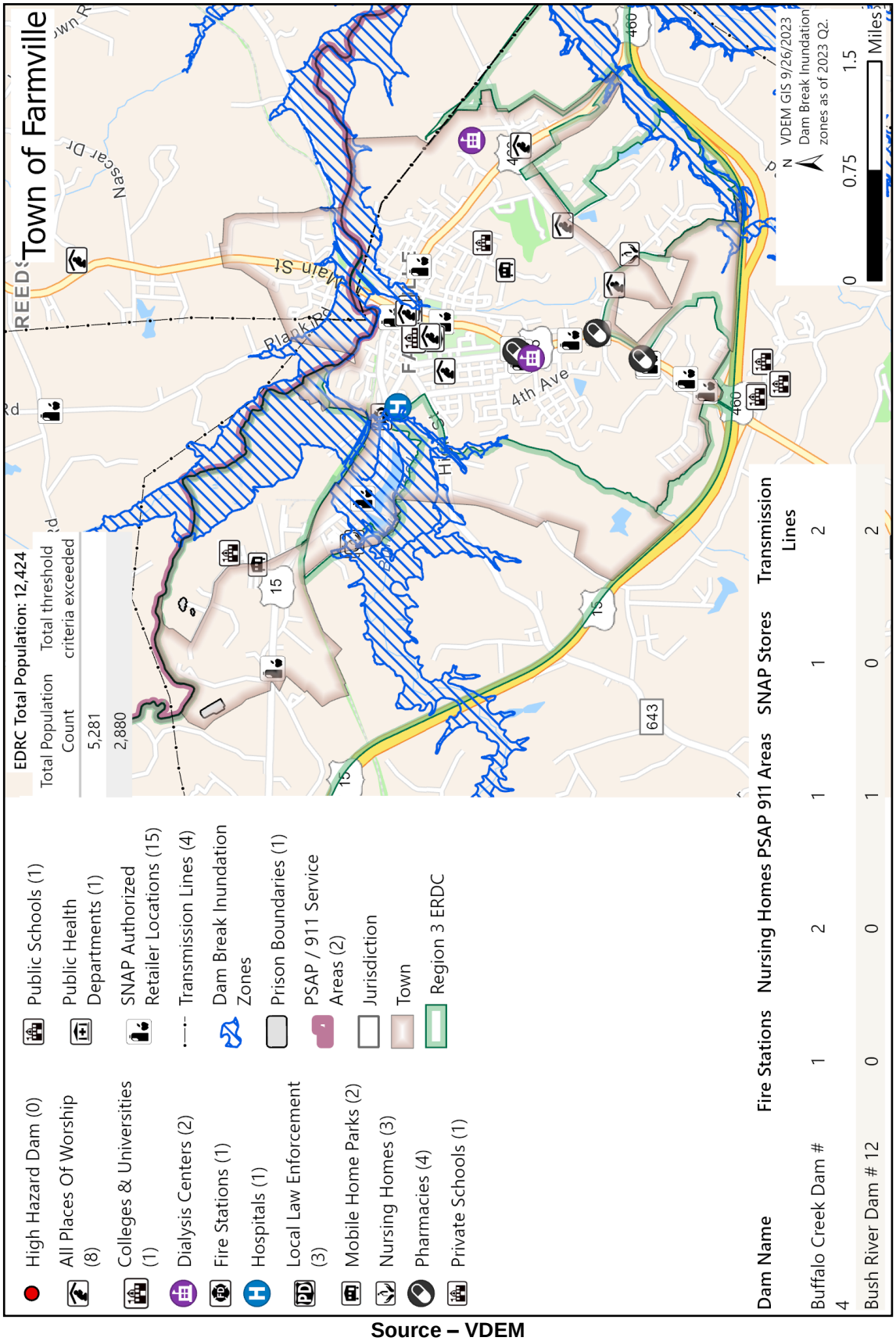
Map 6a.7 – Prince Edward County HHP Dams



DamName	Fire Stations	Nursing Homes	PSAP 911 Areas	SNAP Stores	Transmission Lines
Buffalo Creek Dam # 4	1	2	1	1	0
Bush River Dam # 2	0	0	2	0	2
Bush River Dam # 12	0	0	5	0	6
Bush River Dam # 7	0	0	2	0	3
Bush River Dam # 4B	0	0	1	0	2

Source – VDEM

Map 6a.8 – Farmville HHP Dams



Source – VDEM