

12. Planning Issues

Based on the available data regarding the natural systems in the county, the following planning issues have been identified:

- The scenic beauty of the county is strongly valued. In order to adequately preserve this, what additional land use protections should be considered for agricultural lands and ridgelines?
- The hydrogeologic characteristics of the county make the successful use of wells in some areas a challenge. The depth of wells also varies greatly and in areas of low depth could create problems with groundwater quality. How should the use of wells be better controlled and balanced with the provision of public services?
- Groundwater as a whole is of good quality in the county; however the nature of the system makes it vulnerable to contamination from agricultural runoff. What groundwater source protection measures should the county consider?
- Soil erosion and non-point source pollution is compromising the water quality in streams throughout the county. How should the county protect the water quality of streams?
- There are many flood control dams in the county that currently are considered to pose risks to property and people. What can the county do to prevent development in flood inundation areas?

C. Supplemental Natural Resources Section

1. Introduction

The Natural Resources Report is a supplement to the “Augusta County Comprehensive Plan 2005-2025, Existing Conditions Analysis.” This report contains supplemental data and maps that were not included in the original report.

2. Watersheds

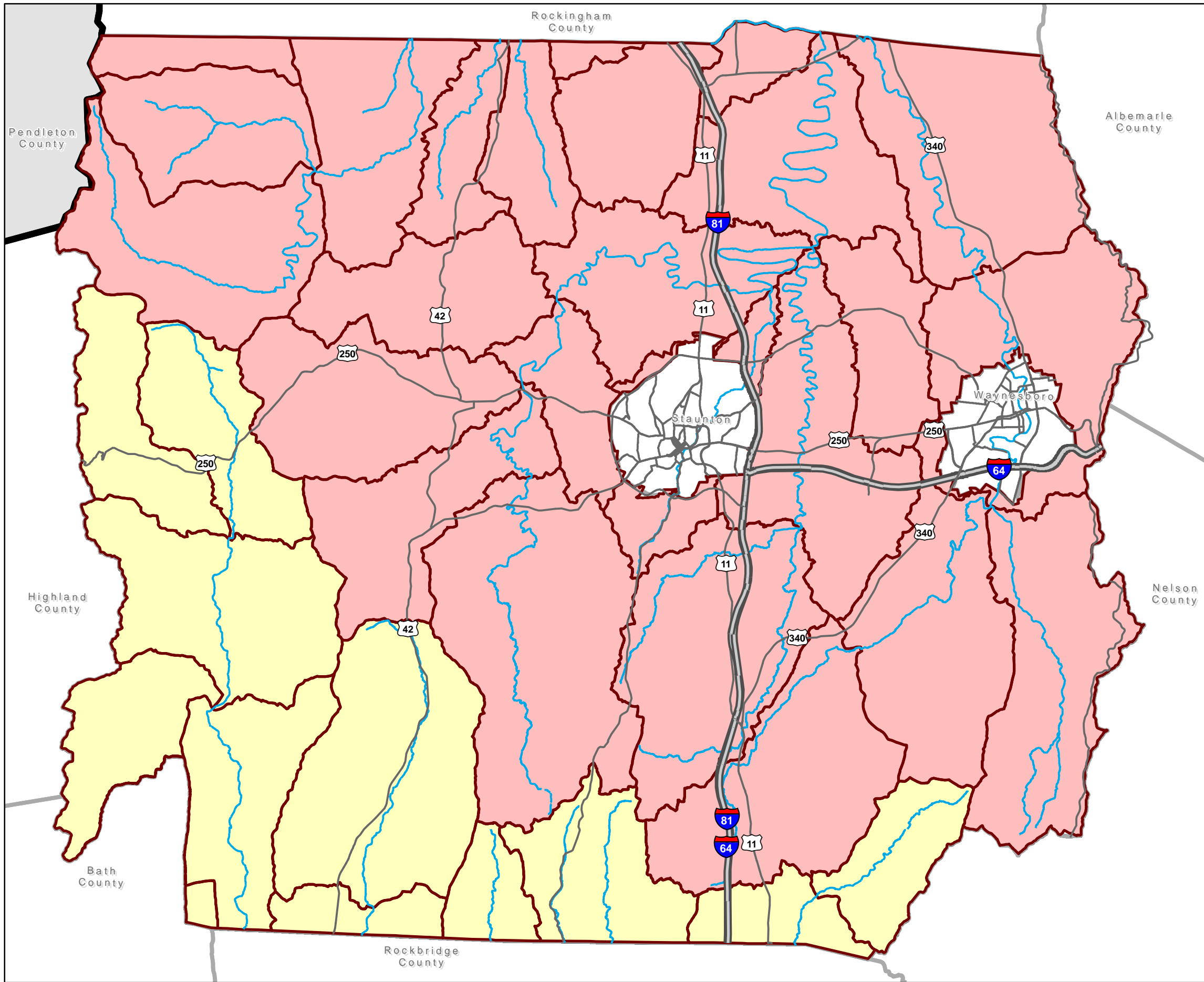
A watershed refers to an area of land that drains water to a particular point along a stream, river, or other waterbody. Topography and surface runoff are the key elements affecting this area of land. The boundary of a watershed is defined by the highest elevations surrounding the waterbody.

Watershed scale varies depending on the drainage area, ranging from large watersheds (e.g. Chesapeake Bay Basin) to small watersheds (e.g. Walker Creek subwatershed). The Hydrologic Unit Classification (HUC) is a system used to organize watersheds.

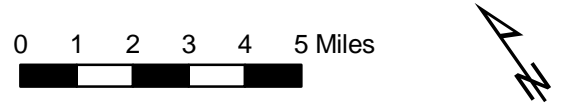
Watersheds are used as an organizing principle for the Natural Resources plan for several reasons:

- They are an irrefutable natural feature,
- All land uses in a common watershed are linked together through drainage, and
- Management strategies can be tailored to unique watershed conditions.

The original Existing Conditions Analysis document divided Augusta County into 21 hydrologic units. This report further subdivides Augusta County into 36 HUCs based on new hydrologic unit standards (HUC-12's) from the Virginia Department of Conservation and Recreation (DCR). These new hydrologic unit standards are used as the basis for state and federal watershed planning. Analysis conducted using these HUCs show that Augusta County is divided into two major river basins, the Shenandoah/ Potomac and Upper James. The Shenandoah major river basin is made up of 24 HUC-12's and the Upper James is comprised of 12 HUC-12's. **Table 8** lists all of the HUC-12's that comprise Augusta County, and **Map 12** shows these HUC-12's.



- Legend**
- Shenandoah Potomac River Basin
 - Upper James River Basin
 - HUC 12
 - Hydrology
 - Roads - Interstate
 - Roads - Primary



Supplemental Natural Resources Section
Map 12
Hydrologic Units (Watersheds)
in Augusta County
 Augusta County
 Comprehensive Plan
 2007-2027



Table 8. Hydrologic Units in Augusta County

HUC 12 Name	River Basin	Area (acres)
(Lower) Little Calfpasture River-Lake Merriweather	Upper James	5174.23
(Upper) Little Calfpasture River-Smith Creek	Upper James	31855.77
(Upper) South River-Marlbrook Creek	Upper James	6985.22
Back Creek-Inch Branch	Shenandoah Potomac	26589.35
Briery Branch	Shenandoah Potomac	5177.39
Calfpasture River-Chair Draft	Upper James	14372.28
Calfpasture River-Fridley Branch	Upper James	16977.13
Calfpasture River-Holloway Draft	Upper James	24431.46
Christians Creek-Barterbrook Branch	Shenandoah Potomac	26026.38
Christians Creek-Folly Mills Creek	Shenandoah Potomac	29115.73
Hamilton Branch	Upper James	12204.77
Hays Creek-Dutch Hollow Branch	Upper James	14762.58
Jennings Branch	Shenandoah Potomac	22783.51
Lewis Creek-Poague Run	Shenandoah Potomac	7576.16
Little River-Big Run	Shenandoah Potomac	16232.53
Long Glade Creek	Shenandoah Potomac	9677.37
Meadow Run	Shenandoah Potomac	12232.62
Middle River-Bell Creek	Shenandoah Potomac	9628.17
Middle River-Broad Run	Shenandoah Potomac	22758.58
Middle River-Buffalo Branch	Shenandoah Potomac	19067.78
Middle River-Eidson Creek	Shenandoah Potomac	39764.08
Middle River-Falling Spring Run	Shenandoah Potomac	20722.65
Mill Creek-Cabin Creek	Upper James	962.24
Moffett Creek	Shenandoah Potomac	17212.59
Mossy Creek	Shenandoah Potomac	8935.32
Naked Creek-North Fork Naked Creek	Shenandoah Potomac	14417.22
North River-Pleasant Run	Shenandoah Potomac	6362.97
North River-Skidmore Fork	Shenandoah Potomac	25309.03
North River-Thorny Branch	Shenandoah Potomac	19061.44
Ramseys Draft	Upper James	13705.61
Saint Marys River	Upper James	10067.01
South River-Canada Run	Shenandoah Potomac	25566.29
South River-Paine Run	Shenandoah Potomac	29402.49
South River-Porterfield Run	Shenandoah Potomac	23836.34
South River-Stony Run	Shenandoah Potomac	26853.38
Walker Creek	Upper James	5768.75

3. Development and Impervious Cover

The Impervious Cover Model (ICM) predicts potential stream quality based on the amount of impervious cover in a given watershed. The ICM is based on a review of over 225 studies, around 50 of which directly support the relationship between watershed impervious cover and overall stream quality⁵. The ICM

⁵ Impacts of Impervious Cover on Aquatic Systems, Center for Watershed Protection, 2003.

predicts that most stream quality indicators decline when watershed impervious cover exceeds 10%, with severe degradation expected beyond 25%. **Figure 2** provides a graphical representation of the ICM. **Table 9** describes typical stream characteristics for the three impervious cover categories of Sensitive, Impacted, and Non-Supporting. These stream characteristics are generalized, and actual conditions for a particular stream are also influenced by topography, geology, soils, and other factors.

Figure 2. Impervious Cover Model

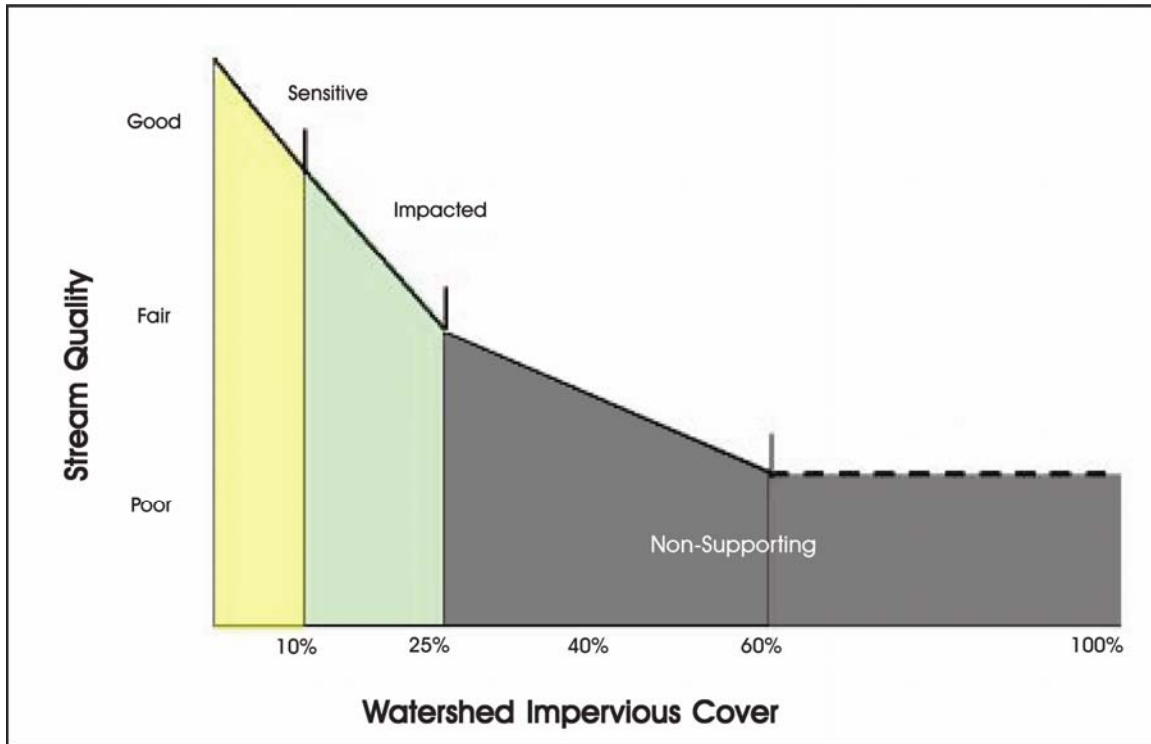
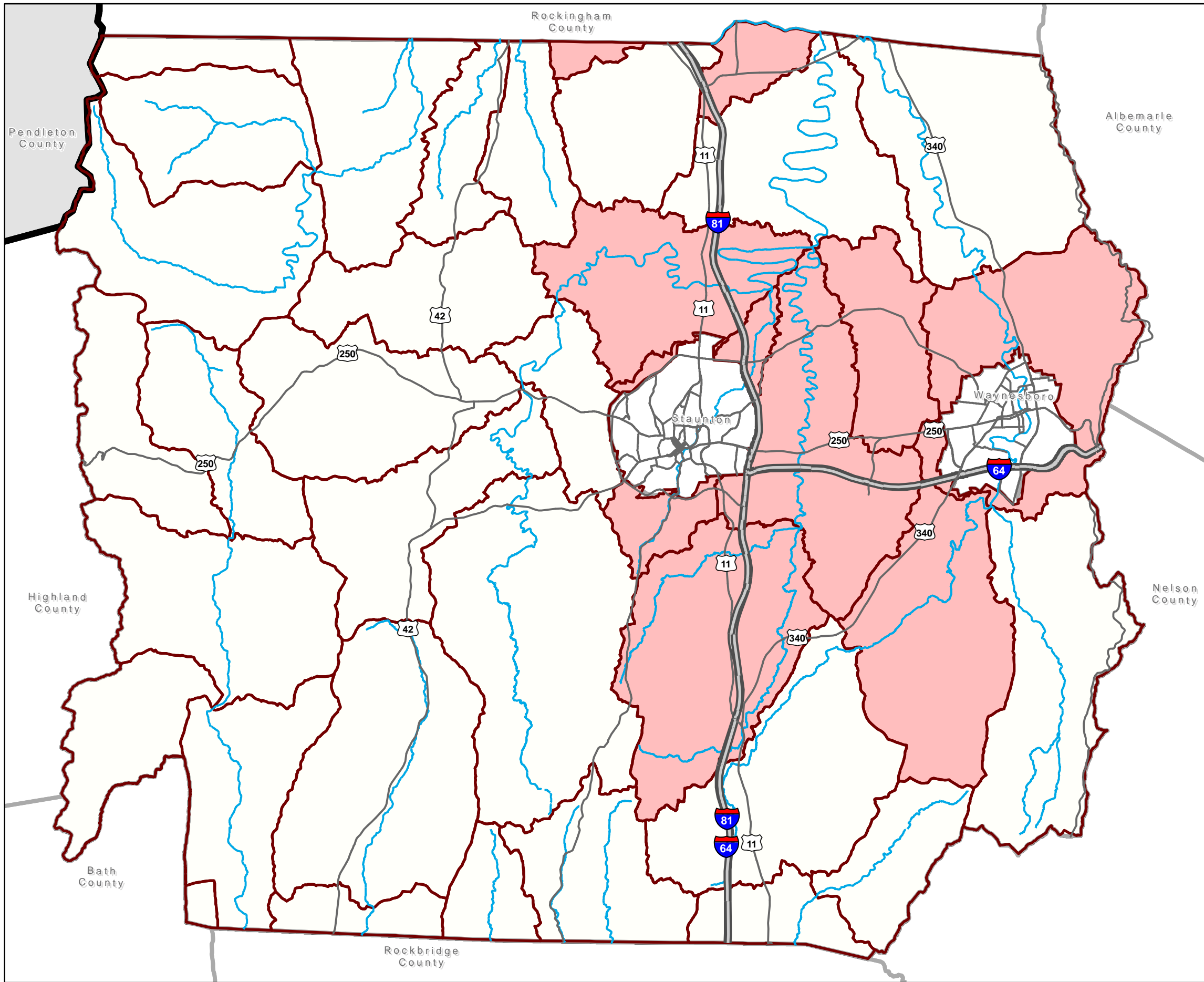


Table 9. Classifications in the Impervious Cover Model

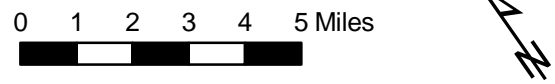
Impervious Cover Category	Stream Characteristics
Sensitive Stream (Impervious Cover ≤10%)	<ul style="list-style-type: none"> ▪ Stable channel ▪ Good to excellent biodiversity ▪ Good to excellent water quality ▪ Stream health indicators may decline due to poor land management practices (agriculture & forestry)
Impacted Stream (Impervious Cover 10-25%)	<ul style="list-style-type: none"> ▪ Channel becoming unstable ▪ Fair to good biodiversity ▪ Fair to good water quality ▪ Stream corridor may still have intact buffer system ▪ High potential to restore biological function
Non-Supporting Streams (Impervious Cover 40-65%)	<ul style="list-style-type: none"> ▪ Poor to no biodiversity ▪ Poor water quality ▪ Tend to not meet designated uses and applicable standards ▪ Restoration focuses on aesthetics, channel stability, and recreation

In Augusta County, all of the hydrologic units contain impervious cover less than 10%, and are thus in the Sensitive category (**Table 9**). Most future growth within the county is targeted to the Urban Service Areas (80% of growth in next 20 years) and, to a lesser extent, Community Development Areas (10% of growth in next 20 years). It is likely that future stream health indicators (e.g., biological health, streambank stability) will be impacted in watersheds that have a substantial amount of land in the Urban Service and Community Development Areas. Several of these watersheds may transition over to the Impacted category. As a result, these watersheds would be excellent target areas for advanced stormwater management, riparian buffer management, and development principles that protect water quality, such as low-impact development.

“Priority Watersheds for Development Impacts” were designated as those that have the highest existing impervious cover within the county and that have high percentages of land in the Urban Service and Community Development Areas. These priority watersheds are shown in bold in **Table 10**, and are also depicted on **Map 13**.



- Legend**
- Priority Watersheds
 - HUC 12
 - Hydrology
 - Roads - Interstate
 - Roads - Primary



Supplemental Natural
 Resources Section
 Map 13
 Priority Watersheds
 for Development
 Impacts
 Augusta County
 Comprehensive Plan
 2007-2027

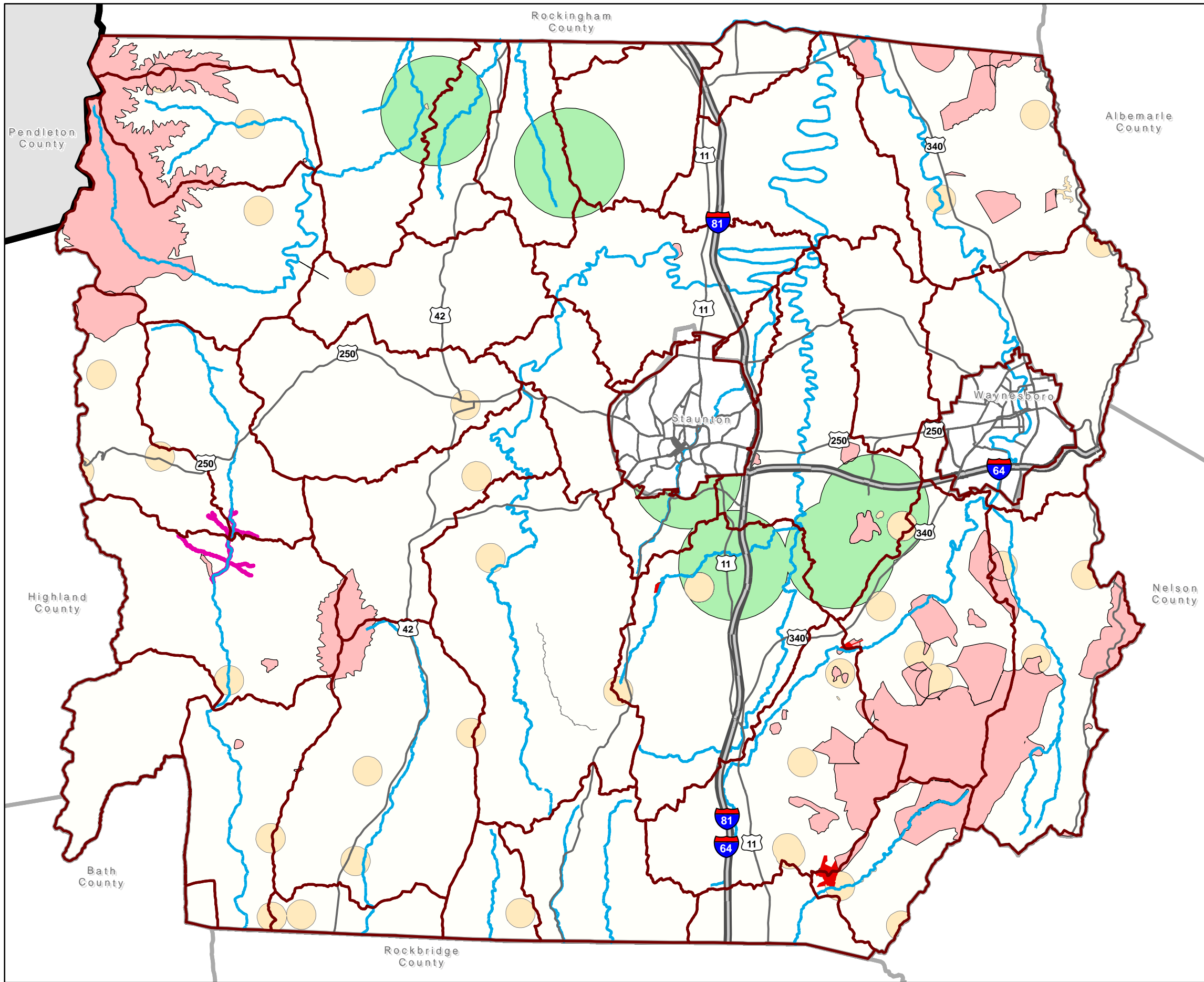


Table 10. Existing Impervious Cover by HUC-12

HUC 12	Impervious Cover (%)
(Lower) Little Calfpasture River-Lake Merriweather	1.60%
(Upper) Little Calfpasture River-Smith Creek	4.27%
(Upper) South River-Marlbrook Creek	4.12%
Back Creek-Inch Branch	5.73%
Briery Branch	0.00%
Calfpasture River-Chair Draft	0.36%
Calfpasture River-Fridley Branch	0.66%
Calfpasture River-Holloway Draft	0.46%
Christians Creek-Barterbrook Branch	5.86%
Christians Creek-Folly Mills Creek	3.80%
Hamilton Branch	0.59%
Hays Creek-Dutch Hollow Branch	2.18%
Jennings Branch	1.43%
Lewis Creek-Poague Run	5.58%
Little River-Big Run	0.04%
Long Glade Creek	2.17%
Meadow Run	4.16%
Middle River-Bell Creek	4.00%
Middle River-Broad Run	4.08%
Middle River-Buffalo Branch	3.29%
Middle River-Eidson Creek	4.09%
Middle River-Falling Spring Run	6.05%
Mill Creek-Cabin Creek	0.00%
Moffett Creek	2.09%
Mossy Creek	2.71%
Naked Creek-North Fork Naked Creek	3.19%
North River-Pleasant Run	7.15%
North River-Skidmore Fork	0.00%
North River-Thorny Branch	2.47%
Ramseys Draft	0.29%
Saint Marys River	0.76%
South River-Canada Run	4.67%
South River-Paine Run	2.60%
South River-Porterfield Run	4.97%
South River-Stony Run	3.03%
Walker Creek	1.75%
<i>Watersheds depicted in bold are Priority Watersheds for Development Impacts</i>	

4. Natural Heritage Resources

Augusta County contains the second highest number of identified natural heritage resources in Virginia. Approximately 17% (164 square miles) of the county contains natural heritage resources (**Map 14**).



Legend

Natural Heritage Resources Data

- State Natural Area Preserves
- Conservation Site
- Karst Feature
- General Location
- SCU
- HUC 12
- Hydrology
- Roads - Interstate
- Roads - Primary

Natural Heritage data was provided by the Virginia Department of Conservation and Recreation February 2007

0 1 2 3 4 5 Miles



Supplemental Natural Resources Section
Map 14
Natural Heritage Resources

Augusta County
Comprehensive Plan
2007-2027



Augusta County is home to 153 natural heritage resources with 56 conservation sites identified as areas necessary for their survival. Natural heritage resources are defined by the Virginia Department of Conservation and Recreation (DCR) – Division of Natural Heritage as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations such as caves and karst features⁶.

Natural heritage resources are categorized as: (1) Conservation Sites, (2) Stream Conservation Units, (3) Karst Features, (4) Natural Area Preserves, and (5) General Natural Heritage Resources. Information on each category in Augusta County is outlined below.

DCR has identified Conservation Sites that include known populations of natural heritage resources as well as adjacent or surrounding habitat necessary to sustain them. While Conservation Sites represent areas that are recommended for protection and stewardship because of the natural heritage resources and habitat they support, they are not currently under an official protection designation.

A particular type of Conservation Site of special interest in Augusta County is the Montaine Depression Wetland, often known locally as Shenandoah Valley Sinkhole Pond. These seasonal or permanent ponds and wetlands are found only in a narrow zone that stretches through eastern Augusta, Rockingham, and Page Counties in the central Shenandoah Valley. Montaine Depression Wetlands are important breeding habitats for amphibians, dragonflies, and damselflies, and are habitat for many rare plants, including federally threatened and state endangered Virginia sneezeweed. Although some ponds are located on U.S. Forest Service land, many remain unprotected and threatened by development, hydrologic alterations, off-road vehicles, and trash dumping. Presently, 33 occurrences of Montaine Depression Wetlands have been documented in Augusta County.

In addition to terrestrial Conservation Sites, Stream Conservation Units (SCUs) have also been developed to identify stream reaches that contain aquatic natural heritage resources. SCUs include an upstream and downstream buffer and all tributaries associated within this reach. One SCU harboring two different species of rare dragonfly has been identified in Augusta County.

Karst Features represent regions of karst topography that harbor significant cave communities and other natural heritage resources (additional information on karst is provided in Section 7 – Groundwater). Karst landscapes provide and support habitat for rare animal and plant species, including bats, cave-adapted invertebrates, plants that grow on the surface and at springs and seeps, and fish and mussels living in streams and rivers fed by karst springs. At least seven significant cave communities occur in Augusta County. The Madison Cave Isopod is listed as both federally and state threatened.

⁶ Natural Heritage Resources (Augusta County), (Report for Comprehensive Plan), Elizabeth Polak, 2006.

There are currently three Natural Area Preserves in Augusta County: (1) Mount Joy Ponds, (2) Cowbane Prairie, and (3) Folly Mills Creek Fen. The Virginia Natural Area Preserve System was established in 1989 to protect and conserve natural heritage resources throughout the state. This system of protected lands is administered by DCR and managed by the Division of Natural Heritage.

General Natural Heritage Resources are sites with a high potential for natural heritage resources, but the occurrences have not been verified by the Natural Heritage Program.

Threats to natural heritage resources and the sites that support them in Augusta County include: habitat fragmentation or destruction; continued logging or clear-cutting of forested areas; erosion, sedimentation and stormwater runoff; herbicide treatment; draining, ditching, and filling of wetlands; nutrient enrichment from agriculture; right-of-way maintenance and power line construction.

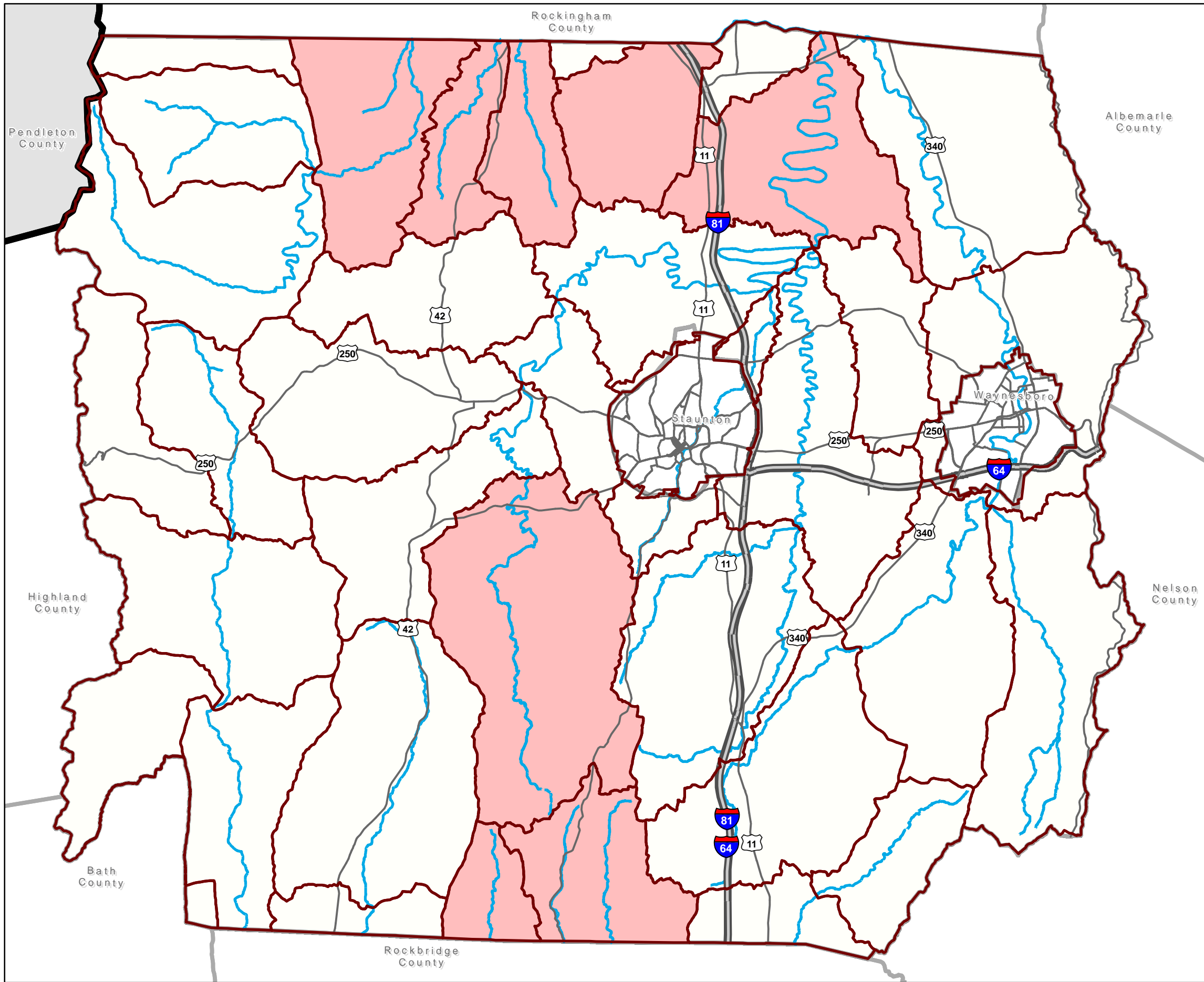
Map 14 shows the approximate locations of natural heritage resources, including Conservation Sites, Stream Conservation Units, Karst Features, Natural Area Preserves, and General Natural Heritage Resources (shown as “General Location” on the map). Many of the natural heritage areas are also within the Priority Watersheds for Development Impacts, meaning that development design should take natural heritage resources into account in order to protect key species and habitats.

5. Natural Resources and Agriculture

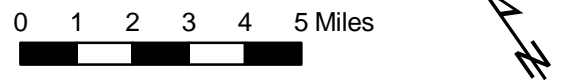
Augusta County is the 2nd leading agricultural county in Virginia, contributing 6% of the state agriculture production. The total revenue from agriculture production in 2002 was \$143,914,000⁷. Natural resources provide a vital link for continued, productive, and healthy agricultural operations. Practices that are vital to maintaining productive agricultural operations include preservation of soils, addressing conflicts with land development, and promotion of good soil and water conservation practices for agricultural land.

“Prime Agricultural Soils”, as defined by USDA, are generally deep (at least 40”), flat (1-3% slope), and well drained. These are generally found on the valley floor (land area between ridges that has moderate rolling topography). However, prime agricultural soils do not necessarily correspond with where active farming is taking place in the county. A better indicator of active farming is the Agricultural Conservation Area (ACA). **Table 11** shows the percentage of ACA land within each HUC-12. Priority Agricultural Watersheds are shown in bold and are also depicted on **Map 15**.

⁷ 2002 Census of Agriculture, Volume 1: Geographic Area Series, USDA – National Agricultural Statistics Service, 2002.



- Legend**
- Priority Agricultural Watersheds
 - HUC 12
 - Hydrology
 - Roads - Interstate
 - Roads - Primary



**Supplemental Natural
 Resources Section
 Map 15
 Priority Agricultural
 Watersheds**

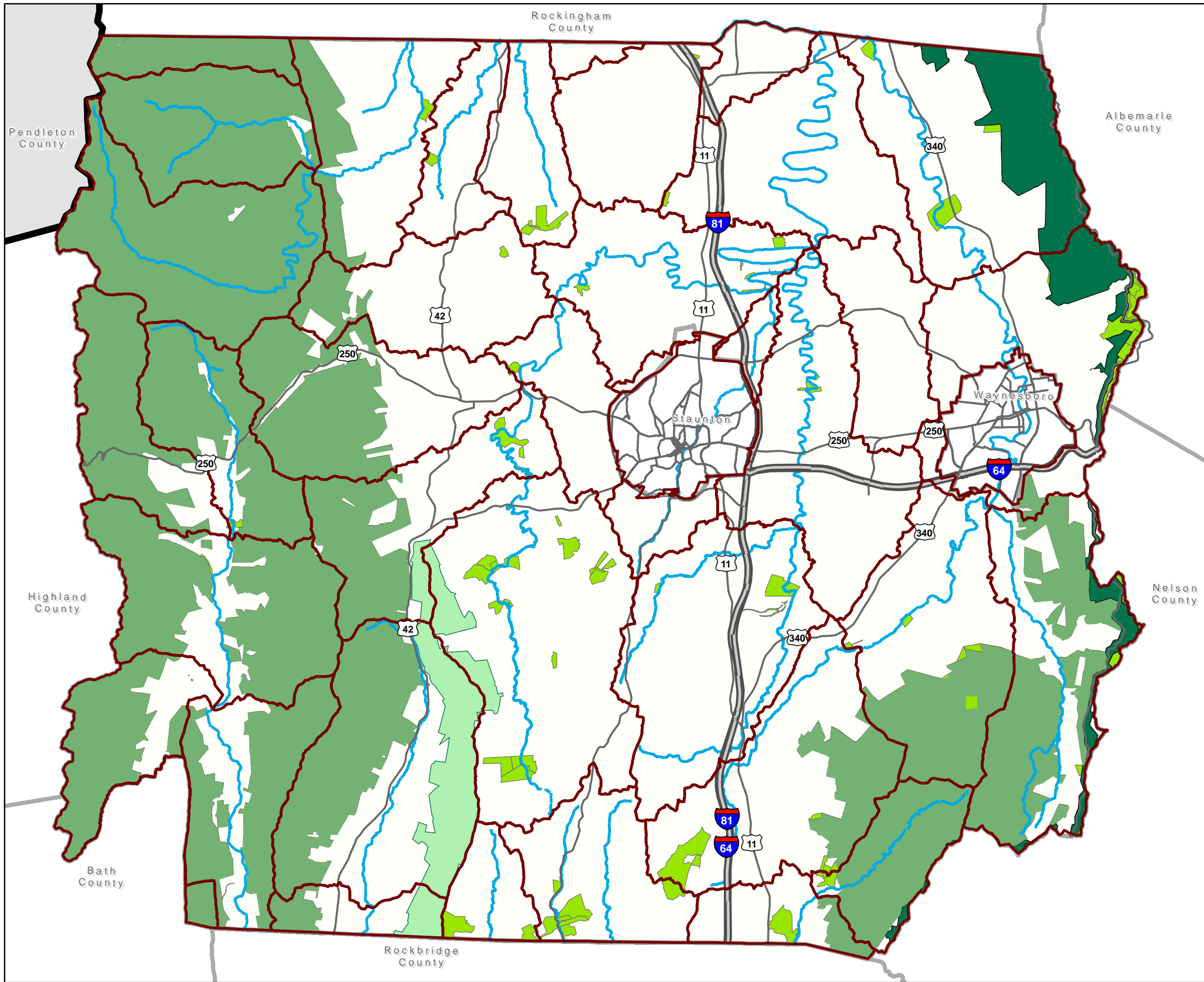
Augusta County
 Comprehensive Plan
 2007-2027



Map 16 shows currently protected land within the county. This land is protected through public ownership or conservation easement. Interestingly, there is not a great deal of protected land within the county's main agricultural areas. Expanding existing conservation easement programs could be an important tool to help maintain a healthy base of agricultural land use in the county. The Priority Agricultural Watersheds noted in **Table 11** may be good target watersheds for an easement program.

Table 11. Agricultural Conservation Areas

HUC 12	Agricultural Conservation Area Land (%)
(Lower) Little Calfpasture River-Lake Merriweather	56.15%
(Upper) Little Calfpasture River-Smith Creek	24.47%
(Upper) South River-Marlbrook Creek	57.19%
Back Creek-Inch Branch	20.99%
Briery Branch	0.00%
Calfpasture River-Chair Draft	8.75%
Calfpasture River-Fridley Branch	31.59%
Calfpasture River-Holloway Draft	17.25%
Christians Creek-Barterbrook Branch	18.19%
Christians Creek-Folly Mills Creek	55.63%
Hamilton Branch	16.54%
Hays Creek-Dutch Hollow Branch	95.37%
Jennings Branch	22.33%
Lewis Creek-Poague Run	6.13%
Little River-Big Run	2.61%
Long Glade Creek	96.74%
Meadow Run	56.69%
Middle River-Bell Creek	57.94%
Middle River-Broad Run	73.39%
Middle River-Buffalo Branch	29.93%
Middle River-Eidson Creek	84.60%
Middle River-Falling Spring Run	52.36%
Mill Creek-Cabin Creek	0.07%
Moffett Creek	75.56%
Mossy Creek	92.72%
Naked Creek-North Fork Naked Creek	74.62%
North River-Pleasant Run	52.81%
North River-Skidmore Fork	0.00%
North River-Thorny Branch	71.94%
Ramseys Draft	20.03%
Saint Marys River	7.07%
South River-Canada Run	1.90%
South River-Paine Run	40.45%
South River-Porterfield Run	19.77%
South River-Stony Run	46.61%
Walker Creek	93.43%
<i>Watersheds depicted in bold are Priority Agricultural Watersheds</i>	



Legend

- Protected Land**
- National Forest
 - National Park
 - State Wildlife Management Area
 - Private Land
 - HUC 12
 - Hydrology
 - Roads - Interstate
 - Roads - Primary

0 1 2 3 4 5 Miles



Supplemental Natural Resources Section
Map 16
Protected Land

Augusta County
Comprehensive Plan
2007-2027



6. Natural Resources and Forestry

Forests provide important benefits to Augusta County. Forests provide habitat for wildlife, improve water quality, mitigate flooding, and minimize erosion. Forest lands are also important for tourism and recreation. Fifty-eight percent of the county is currently forested. The majority (59%) of this forest land is publicly-owned by the U.S. Forest Service, National Park Service, Virginia Department of Game & Inland Fisheries, and the Commonwealth of Virginia. However, most commercial harvesting operations take place on private forest land⁸. For this reason, forestry land uses and management practices on private land are of utmost economic and environmental importance to Augusta County.

Augusta County ranked 6th in the state for timber harvest production in 2000⁹ (VCC, 2003). The forest industry in Augusta County produces a total economic benefit of over \$283 million dollars⁸. Forests are also a renewable resource. In 2001, 2.5 million cubic feet of forest products were harvested, and yet the county saw a net growth in timber volume of over 750,000 cubic feet. The net growth was due to growth in timber stands and reforestation efforts¹⁰.

As Augusta County becomes more developed, forest tracts are fragmented into smaller parcels. Owners of smaller forest tracts generally have a different and more critical perspective about forest harvesting on their own and their neighbors' properties. The owners of the smaller parcels are less likely to carry out meaningful forestry operations and more likely to complain about nearby operations. Furthermore, it is more difficult to manage forests on smaller tracts of land (e.g. 10 acres) than larger tracts (e.g. 100 acres) due to the nature of forestry operations and equipment. **Map 17** shows the forest tracts that are located in Augusta County.

The Virginia Department of Forestry (VDOF) has identified areas of the county where there are potential conflicts between forest land and residential subdivisions, and an increased risk from wildfires. VDOF calls these areas "Wildland Urban Interface" areas, and the residential areas are known as "Woodland Home Communities". This risk of wildfires increases in these woodland communities due to poor road access and layout that makes them inaccessible to fire trucks. The greatest fire risk is to communities located adjacent to parkland. **Map 18** shows the location of Wildfire Risk Areas, Wildland Urban Interface areas, and Woodland Home Communities.

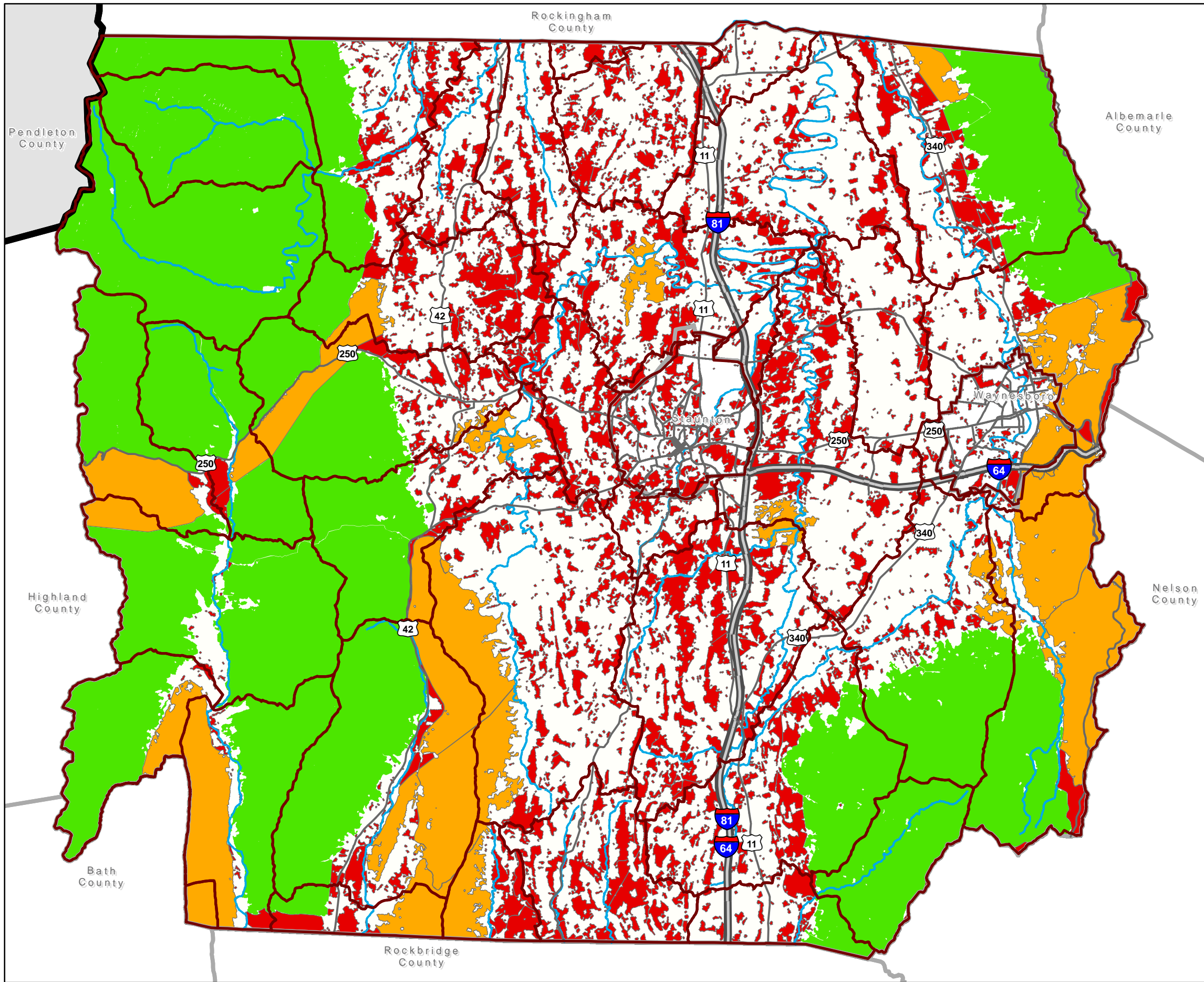
7. Groundwater

Groundwater constitutes almost 100% of domestic water supply for Augusta County. Community water systems, primarily operated by the Augusta County Service Authority, serve over 14,000 households. ACSA operates 12 water

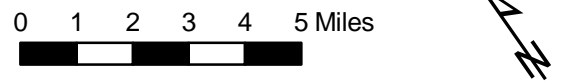
⁸ Forest Resources in Augusta County, Virginia Department of Forestry, 1999.

⁹ State of the Valley Report, Valley Conservation Council, 2003.

¹⁰ Forestry in Augusta County: A Healthy Environment and a Thriving Industry, Virginia Department of Forestry, 2006.

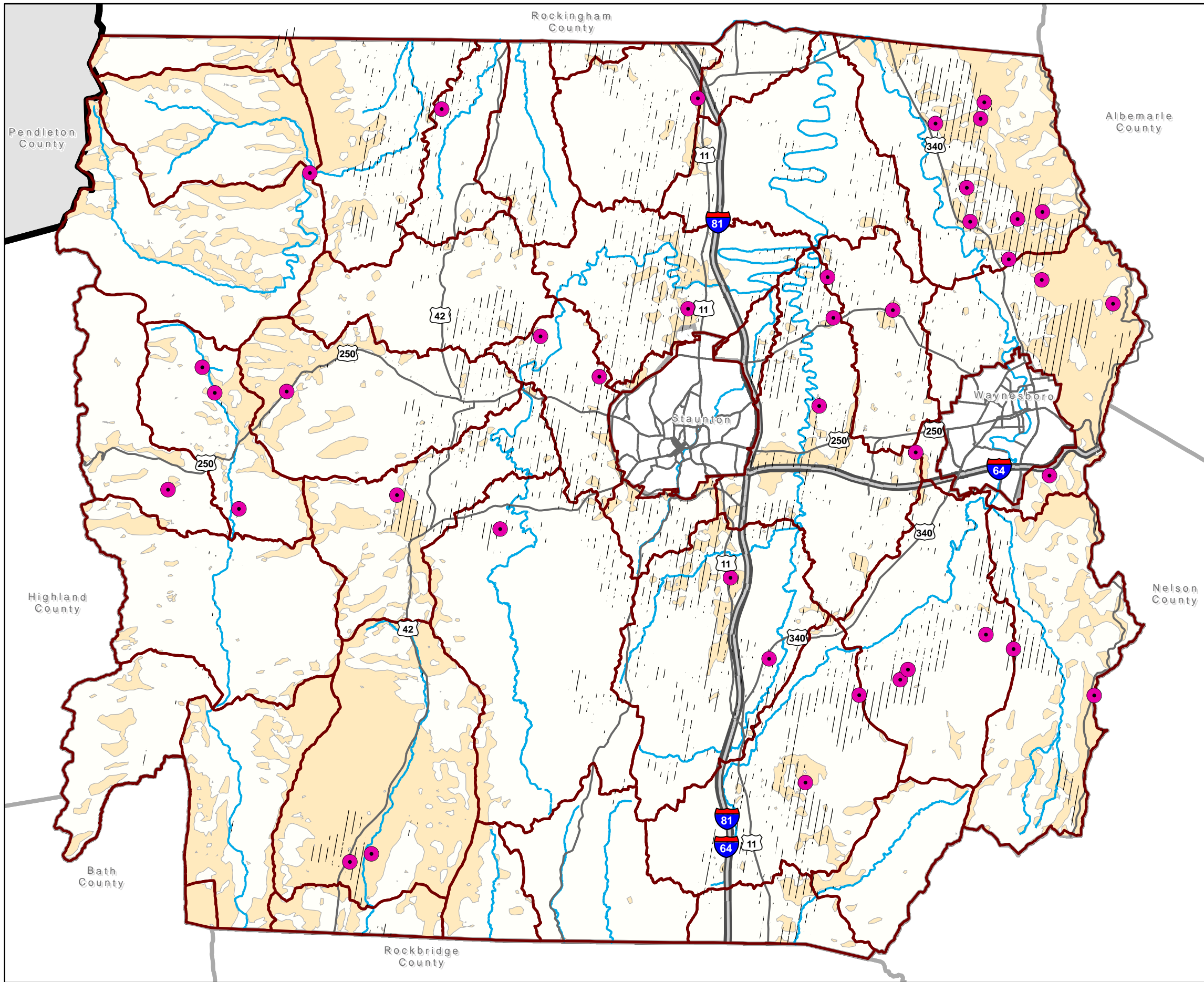


- Legend**
- Forested Areas**
- 0 - 100
 - 101 - 1,000
 - > 1,001
 - HUC 12
 - Hydrology
 - Roads - Interstate
 - Roads - Primary



Supplemental Natural Resources Section
Map 17
Forest Patches
> 100 Acres
 Augusta County
 Comprehensive Plan
 2007-2027





Legend

- Wildfire Risk Assessment - High
- Woodland Communities
- Wildland/Urban Interface
- HUC 12
- Hydrology
- Roads - Interstate
- Roads - Primary

0 1 2 3 4 5 Miles



Supplemental Natural
Resources Section
Map 18
Wildfire Risk Assessment,
Wildland/Urban Interface,
and Woodland Communities

Augusta County
Comprehensive Plan
2007-2027

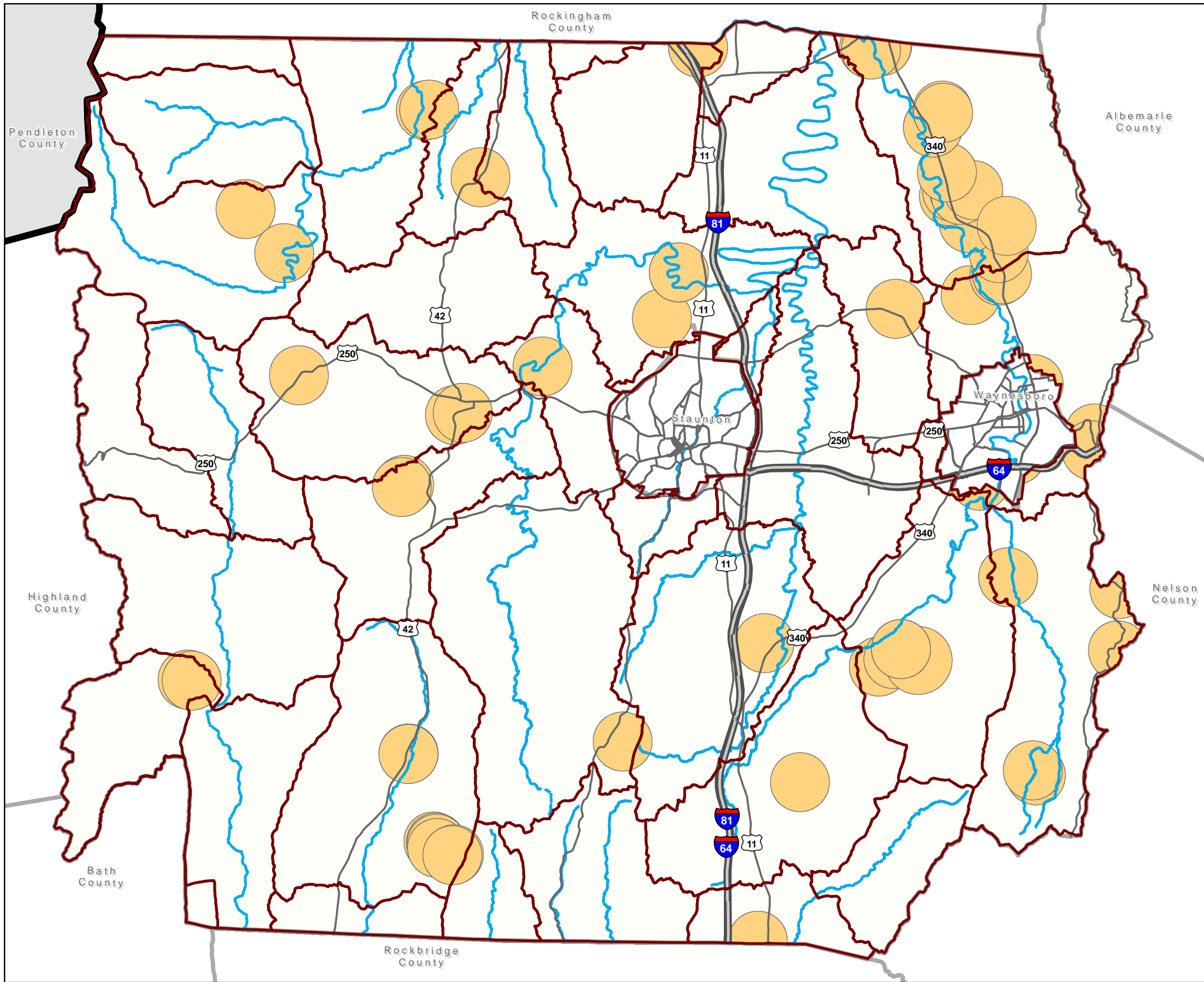


systems comprised of approximately 130 individual supply wells¹¹. The remainder of the county is served by private, individual wells. As such, provision of an adequate and clean supply of groundwater is a critical issue for Augusta County. The ACSA and the County are working on a source water protection plan and ordinance. Two source water protection zones are identified based on the Virginia Department of Health Source Water Assessment Program (SWAP). The most sensitive zone is a 1,000 foot fixed radius from each wellhead. The secondary zone is a 1-mile fixed radius from each wellhead.

The ACSA is also working on studies to identify more detailed source water zones to further protect its public water supplies. Delineating more detailed source water zones is very important, especially in karst areas. Within karst areas, water can travel relatively long distances at a rapid rate. Therefore, the zones that influence a particular water supply may be well outside the Department of Health SWAP zones.

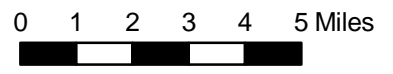
Table 12 shows the area of Virginia Department of Health SWAP zones for each HUC-12. **Map 19** shows the SWAP zones graphically.

¹¹ Fiscal Year 2006 Annual Report DRAFT, Augusta County Service Authority, 2006.



Legend

- Source Water Protection Zones
- HUC 12
- Hydrology
- Roads - Interstate
- Roads - Primary



Supplemental Natural Resources Section
 Map 19
 ACSA Source Water Protection Zones

Augusta County
 Comprehensive Plan
 2007-2027



Table 12. SWAP Zones by Watershed

HUC 12	SWAP (Acres)	SWAP (%)
(Lower) Little Calfpasture River-Lake Merriweather	0.00	0.00%
(Upper) Little Calfpasture River-Smith Creek	4610.71	14.47%
(Upper) South River-Marlbrook Creek	1120.42	16.04%
Back Creek-Inch Branch	5986.35	22.51%
Briery Branch	0.00	0.00%
Calfpasture River-Chair Draft	0.00	0.00%
Calfpasture River-Fridley Branch	164.41	0.97%
Calfpasture River-Holloway Draft	383.28	1.57%
Christians Creek-Barterbrook Branch	0.00	0.00%
Christians Creek-Folly Mills Creek	2388.83	8.20%
Hamilton Branch	1646.37	13.49%
Hays Creek-Dutch Hollow Branch	0.00	0.00%
Jennings Branch	4439.36	19.48%
Lewis Creek-Poague Run	6.98	0.09%
Little River-Big Run	103.49	0.64%
Long Glade Creek	860.55	8.89%
Meadow Run	1988.49	16.26%
Middle River-Bell Creek	1893.40	19.67%
Middle River-Broad Run	95.08	0.42%
Middle River-Buffalo Branch	2199.43	11.53%
Middle River-Eidson Creek	1632.39	4.11%
Middle River-Falling Spring Run	3851.91	18.59%
Mill Creek-Cabin Creek	0.00	0.00%
Moffett Creek	0.00	0.00%
Mossy Creek	1901.33	21.28%
Naked Creek-North Fork Naked Creek	959.73	6.66%
North River-Pleasant Run	261.40	4.11%
North River-Skidmore Fork	3916.18	15.47%
North River-Thorny Branch	1409.74	7.40%
Ramseys Draft	0.00	0.00%
Saint Marys River	0.00	0.00%
South River-Canada Run	4926.60	19.27%
South River-Paine Run	11621.90	39.53%
South River-Porterfield Run	5015.99	21.04%
South River-Stony Run	2205.45	8.21%
Walker Creek	559.07	9.69%
<i>Watersheds depicted in bold are Priority Watersheds for Groundwater Protection</i>		

Another important groundwater issue for Augusta County is the preponderance of “karst terrain.” Karst refers to the landscape characterized by the dissolution of bedrock, leading to underground drainage patterns and unique landforms, such as

sinkholes and caves. In the Shenandoah Valley, karst is characterized by carbonate rocks, chiefly limestone and dolomite¹².

Hazards associated with karst include: (1) subsidence and collapse of the ground surface, (2) sinkhole flooding, and (3) increased vulnerability for groundwater contamination¹³. The third hazard represents the most widespread and significant risk, especially in a place like Augusta County where the population depends on groundwater for its drinking water supply. Contaminants in karst have the potential to travel more quickly and for greater distances compared to other landscapes, especially if waste materials are dumped into sinkholes. Another significant hazard is the formation of new sinkholes or the enlargement of existing sinkholes where development and impervious surfaces change flow patterns and increase discharge rates. Due to the risk of groundwater contamination and new sinkhole formation, development on karst land must be carefully planned.

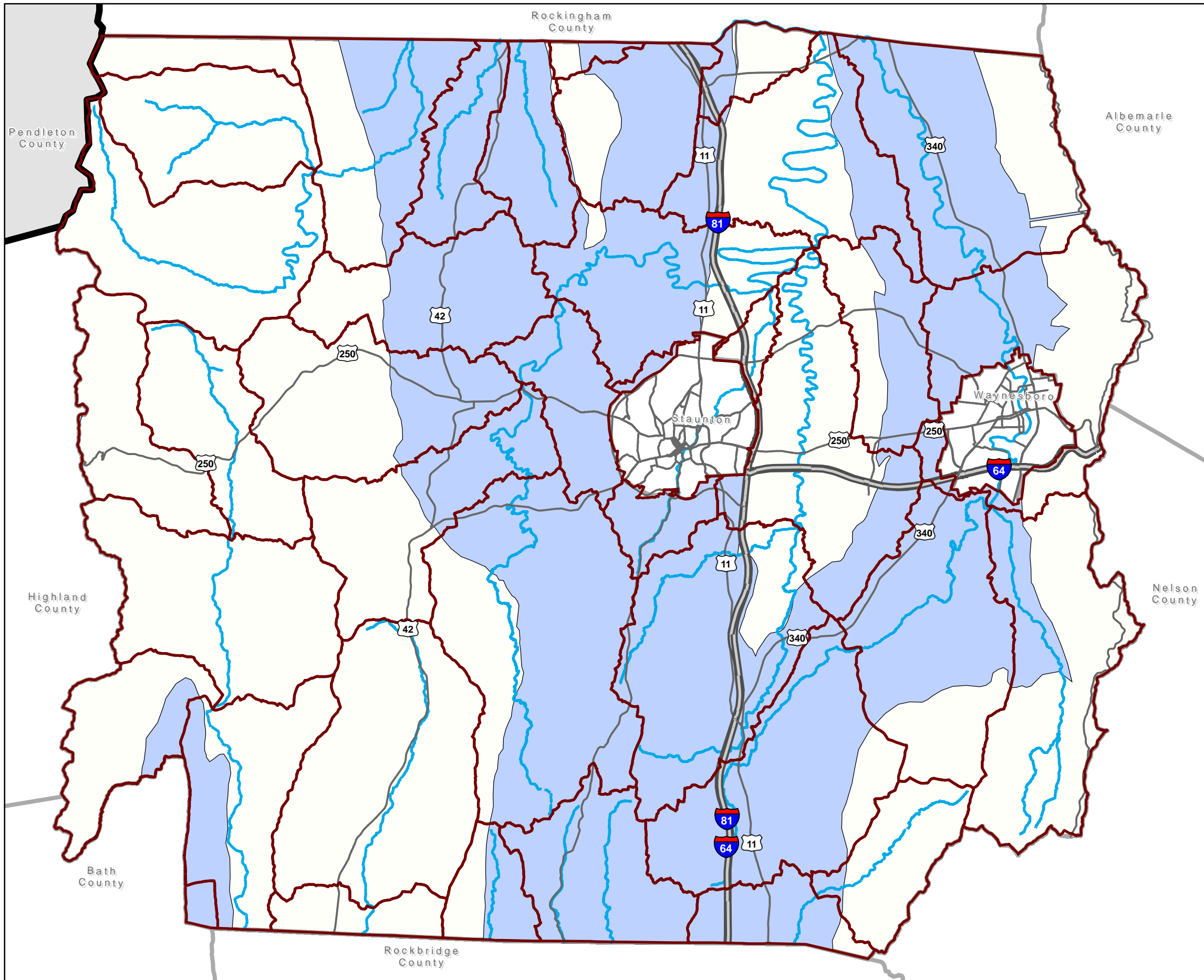
Nearly 45% of Augusta County can be characterized as karst land (underlain by various forms of limestone and dolomite). This land is generally on the valley bottoms, as opposed to the steep ridges and hillsides. **Map 20** shows the generalized karst areas in the county.

Leaking Underground Storage Tanks (LUSTs) are important potential contaminant threats. The Virginia Department of Environmental Quality (DEQ) categorizes LUST cases as either “Open” or “Closed.” Open cases are under active investigation. Closed cases are not being investigated because DEQ has determined that there is no nearby receptor (e.g., an adjacent well) that could become contaminated. However, new development that relies on groundwater could become threatened if located in proximity to either open or closed cases. Recent data from DEQ for Augusta County indicates that there are 14 open cases and 248 closed cases. **Map 21** shows the distribution of LUSTs in the county.

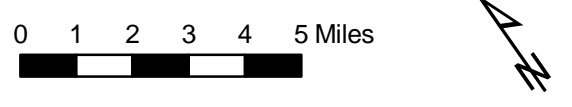
Priority Watersheds for Groundwater Protection were identified based on a combination of SWAP zones for public water supplies and the amount of karst land within the watershed (LUSTs are fairly evenly distributed across the county, so did not factor into the identification of priority watersheds). **Map 22** shows these priority watersheds. These watersheds are also shown in bold in **Table 12**. While these watersheds are very important for the protection of public water supplies, it should be understood that all of the county’s land, and especially the karst land, is important for groundwater recharge for private water supplies. Development patterns and design and homeowner practices are critical considerations to protect groundwater for current and future residents.

¹² Selected Karst Features of the Northern Valley and Ridge Province, Virginia, David A. Hubbard, DCR, 1983. Selected Karst Features of the Central Valley and Ridge Province, Virginia, David A. Hubbard, DCR, 1988.

¹³ Use of Regional Sinkhole Mapping for Sinkhole Susceptibility Maps, David A. Hubbard, 2003.



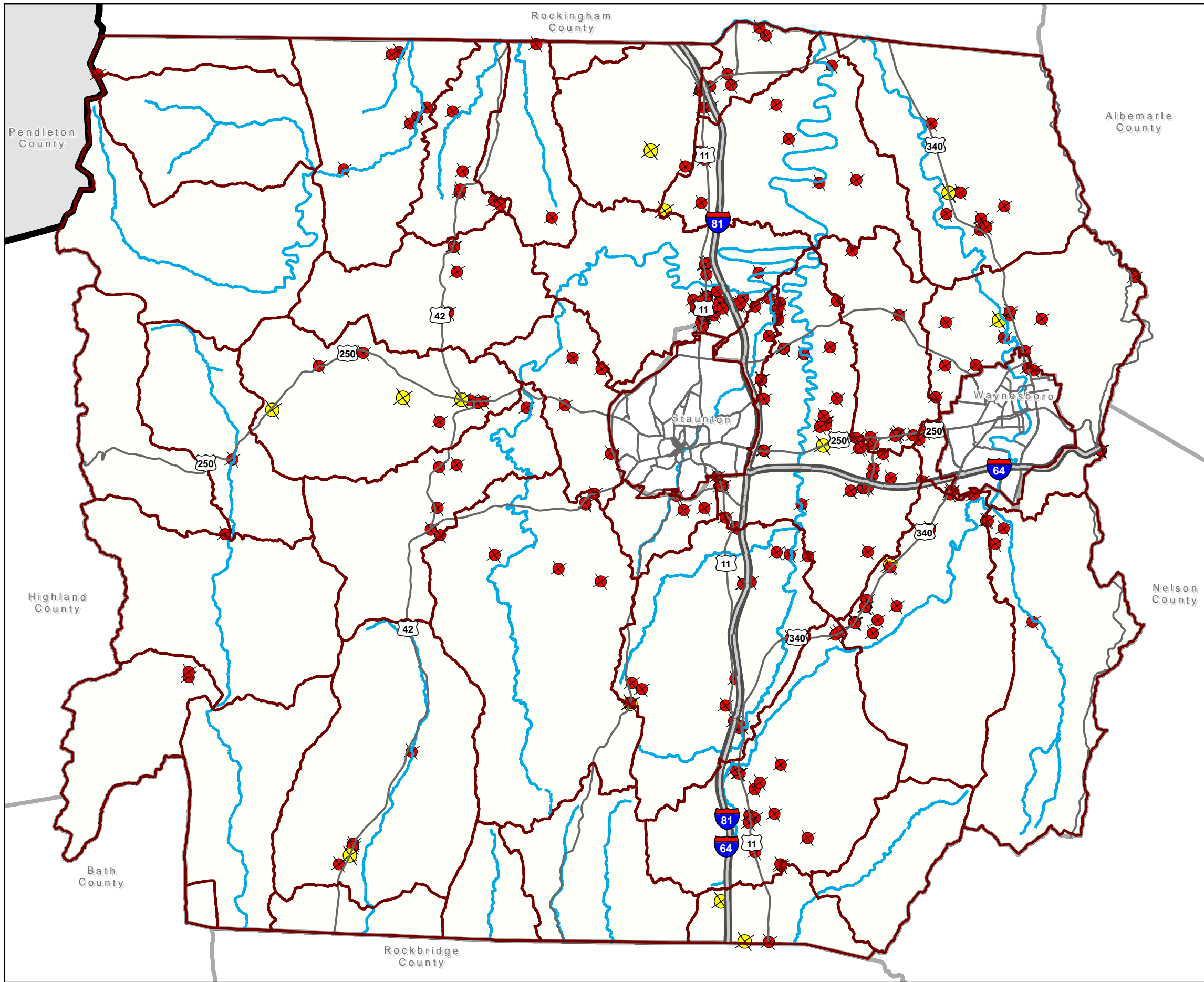
- Legend**
- Karst Geologic Zones
 - HUC 12
 - Hydrology
 - Roads - Interstate
 - Roads - Primary



Supplemental Natural
Resources Section
Map 20
Karst Geologic Zones

Augusta County
Comprehensive Plan
2007-2027

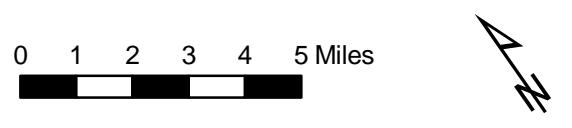




Legend

Leaking Underground Storage Tanks Status

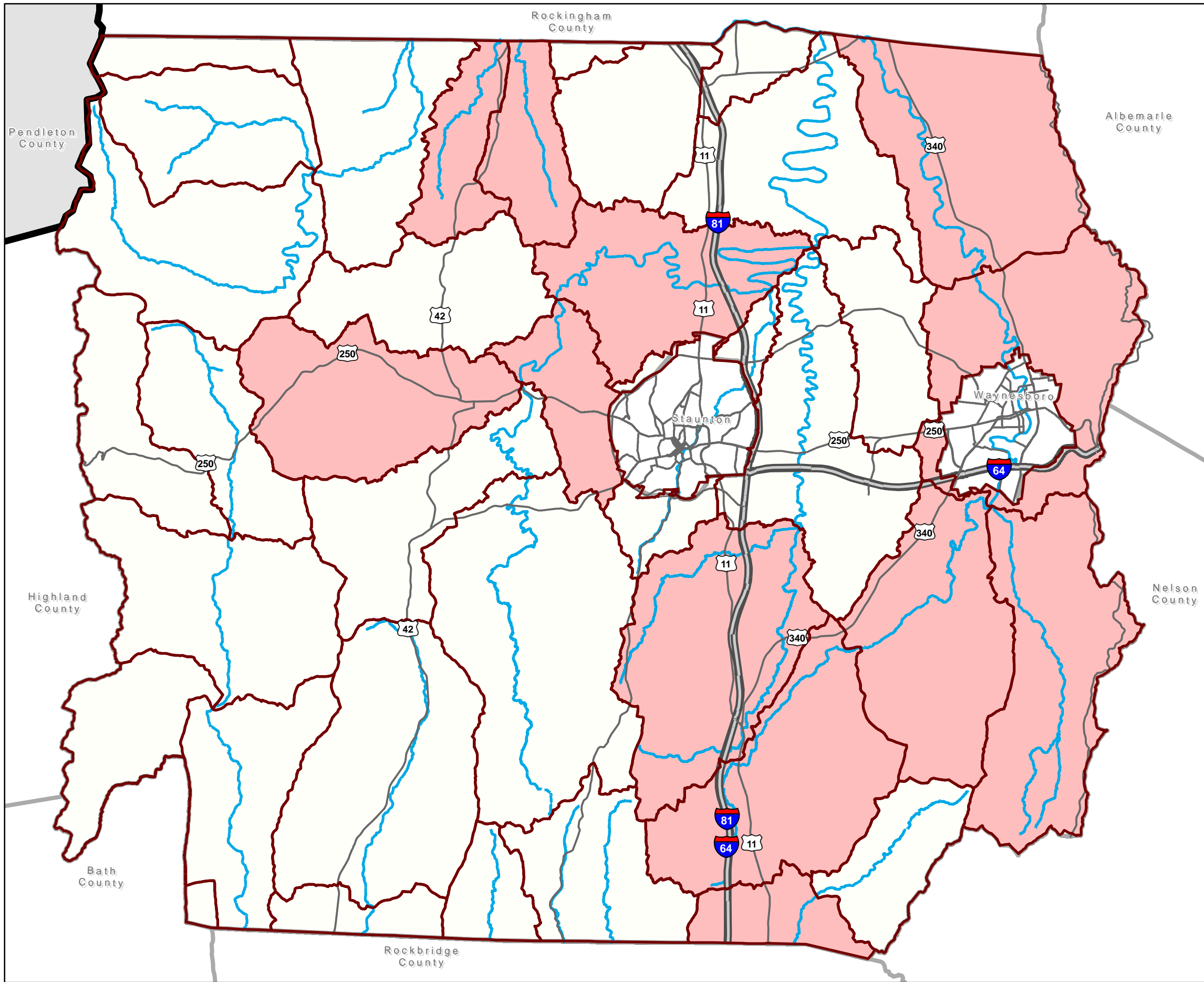
- Open
- Closed
- HUC 12
- Hydrology
- Roads - Interstate
- Roads - Primary








Supplemental Natural Resources Section
 Map 21
 Leaking Underground Storage Tanks

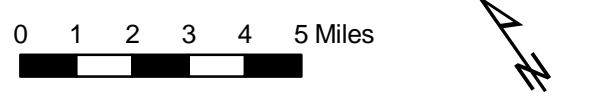
Augusta County
 Comprehensive Plan
 2007-2027





Legend

-  HUC 12
-  Hydrology
-  Roads - Interstate
-  Roads - Primary
-  Priority Watersheds for Groundwater Protection



Supplemental Natural Resources Section
 Map 22
 Priority Watersheds for Groundwater Protection
 Augusta County
 Comprehensive Plan
 2007-2027



8. Flood Control

Augusta County has experienced repeated flooding in its history. Known floods occurred in 1896, 1936, 1942, 1985, 1992, 1996, and 1998. Monetary damages from these floods have exceeded \$20 million. The areas of the county of most concern for flooding include¹⁴:

- Ramseys Draft near Routes 250 and 716
- West Dry Branch located along Routes 688 and 689
- Calfpasture River and tributaries in Deerfield along Routes 600, 692, and 629
- Little Calfpasture River and tributaries in Craigsville and Augusta Springs
- Buffalo Branch in Buffalo Gap along Routes 42 and 688
- Dry Branch southwest of Churchville along Routes 868, 720, 723, 220, 42, and 932
- Jennings Branch and North River in Lone Fountain and Churchville along Routes 720 and 250
- North River tributaries in Franks Mill along Routes 728, 732, and 721
- Jennings Branch and Buckhorn Creek west of Churchville on Route 250
- North River tributaries in Weyers Cave off Route 276
- South River tributaries in Harriston near Route 778
- South River tributaries in Lyndhurst along Routes 624 and 664
- Middle River in Verona along Routes 781 and 11
- Back Creek in Sherando along Routes 664 and 814
- South River and tributaries in Stuarts Draft
- Saint Marys/South River tributaries in Steeles Tavern along Routes 608 and 702.

Past flood control efforts included the construction of various flood control dams. These were built primarily in the 1950s and, with a few exceptions, are operated by Headwaters Soil & Water Conservation District (SWCD). Collectively, there are 16 flood control dams: 13 in the Upper South River Watershed and 3 in the Upper North River Watershed. Several other dams in the county are high enough and/or store enough water so that they are subject to state dam safety regulations, administered by the Department of Conservation & Recreation. **Table 13** provides information on the flood control dams as well as known dams subject to Dam Safety Regulations.

When the flood control dams were constructed, they had a low hazard classification (risk to downstream property in the extreme case of a dam breach). Their original purpose was to protect downstream agricultural land from flooding. However, subsequent development of downstream houses and businesses has raised the hazard ranking. Several of the dams are now subject to costly spillway

¹⁴ Central Shenandoah Valley Regional Flood Mitigation Plan, Central Shenandoah Planning District Commission, 2002.

improvements so that they can safely pass the volume of water associated with the “Probable Maximum Flood”¹⁵.

The county, Headwaters SWCD, and the City of Waynesboro have taken steps to map the downstream breach inundation zones for various flood control dams. This is the zone that would be inundated in the case of a catastrophic dam failure. Inundation zones have been carefully modeled for three dams -- Robinson Hollow, Inch Branch, and Toms Branch – as part of a plan for spillway improvements. Inundation zones have been approximated for six other dams. Detailed studies and dam improvement plans will be an ongoing process for the county and Headwaters SWCD.

Map 23 shows flood control dams and known dams that are subject to Dam Safety Regulations, as well as breach inundation zones for which mapping data are available.

Table 13. Flood Control Dams & Dams Subject to State Dam Safety Regulations

Augusta County Flood Control Dams & Dams Subject to Dam Safety Regs							
Watershed	FC/DS*	Dam	Number	Date Built	O&M	Deficiency	Inundation Zone Status
South River	FC/DS	Robinson Hollow	23	1956	Headwaters	Pass PMF	H&H 2005
South River	FC/DS	Inch Branch	26	1956	Headwaters	Pass PMF	H&H 2005
South River	FC/DS	Toms Branch	25	1957	Headwaters	Pass PMF	H&H 2005
South River	FC/DS	Happy Hollow	24	1954	Headwaters		Hand drawn USGS 7.5"
South River	FC/DS	Lofton Lake	4	1959	Headwaters		Hand drawn USGS 7.5"
South River	FC/DS	Wayneboro Nurseries	19	1957	Headwaters	Spillway erodibility study required	Hand drawn USGS 7.5"
South River	FC/DS	Stoney Creek	6	1959	Headwaters	Spillway	Hand drawn USGS 7.5"
South River	FC/DS	Wilda Lake	7	1957	Headwaters	Spillway erodibility study required	Hand drawn USGS 7.5"
South River	FC/DS	Canada Run	11	1957	Headwaters		Hand drawn USGS 7.5"
South River	FC/DS	Poor Creek	3	1958	Dept of Corrections		
South River	FC/DS	Jones Hollow	8A	1980	City of Waynesboro		
South River	FC/DS	Mills Creek	10A	1963	Augusta County		
South River	FC/DS	Upper Sherando	27	1958	US Forest Service		
South River	DS	Coles Run			ACSA		
South River	DS	Penroyal Farm			Private		
Upper North River	FC/DS	Todd Lake	10	1963	Headwaters	Spillway erodibility study required	
Upper North River	FC/DS	Elkhorn Lake	76	1965	City of Staunton		
Upper North River	FC/DS	Hearthstone Lake	77	1966	Headwaters		
Upper North River	DS	Staunton Dam			City of Staunton		

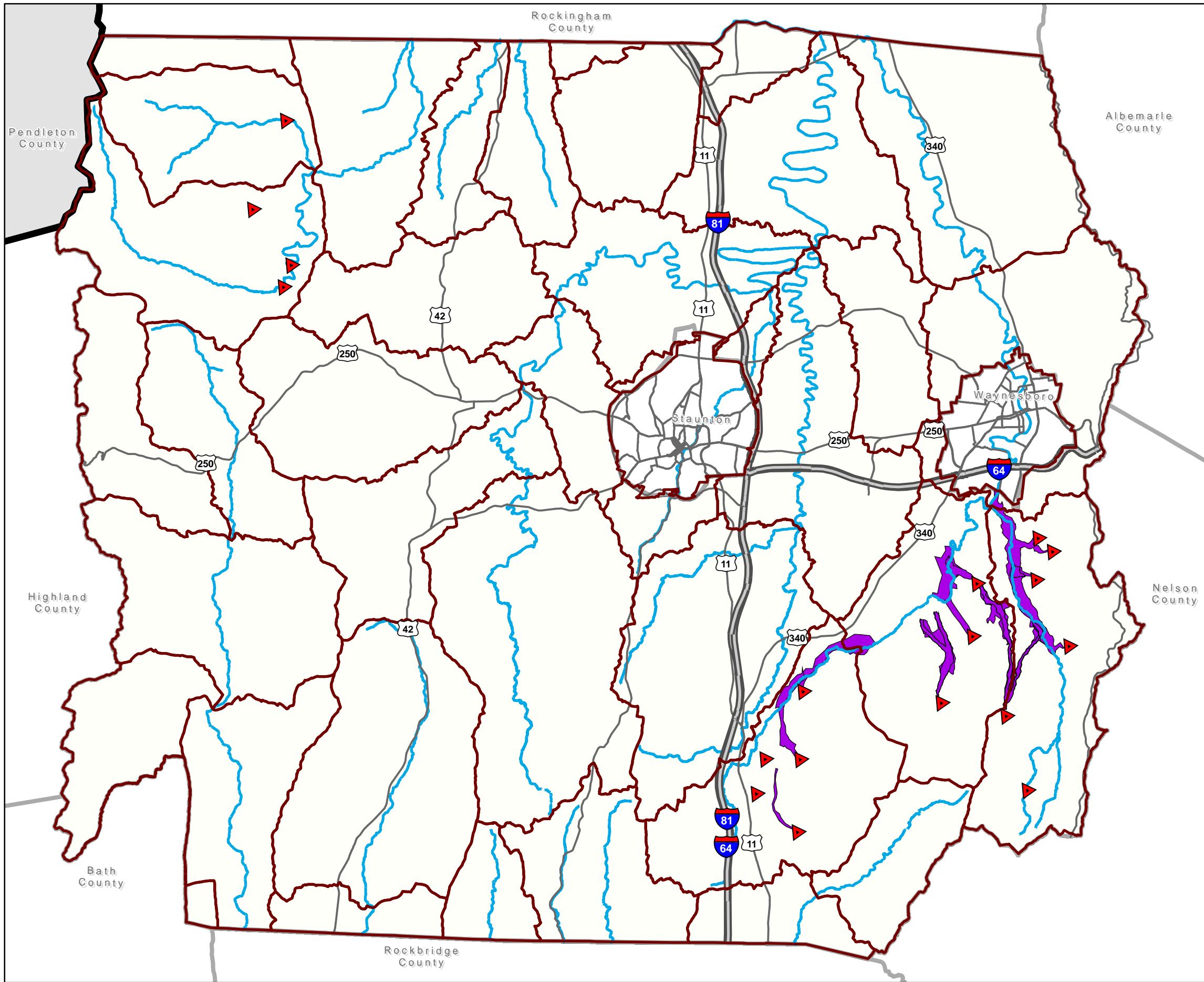
* FC = flood control dam; DS = subject to VA Dam Safety Regs







9. Surface Water

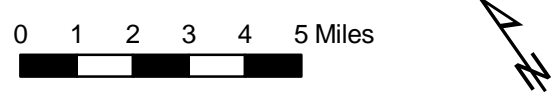
Under the Clean Water Act, states are required to develop a list of impaired streams, known as the 303(d) List. Virginia has water quality standards that determine the designated use for each stream. There are six designated uses for surface waters in Virginia: aquatic life, fish consumption, shellfish consumption, swimming, public water supplies, and wildlife¹⁶.

¹⁵ Supplemental Watershed Plan – Environmental Assessment for the South River Watershed, USDA-Natural Resources Conservation Service, 2005.

¹⁶ Final 2006 305(b)/303(d) Water Quality Assessment Integrated Report, Virginia Department of Conservation and Recreation, 2006.



- Legend**
-  Flood Control Dams
 -  Mapped Inundation Zones
 -  HUC 12
 -  Hydrology
 -  Roads - Interstate
 -  Roads - Primary



Supplemental Natural Resources Section
 Map 23
 Flood Control and Safety Dams

Augusta County
 Comprehensive Plan
 2007-2027



Water quality monitoring data is used to determine if the stream exceeds the water quality standards and should be listed on the 303(d) List. Water quality monitoring is conducted by various groups including Virginia Department of Environmental Quality (DEQ) and volunteer groups (e.g. watershed organizations).

In Augusta County, the 2006 303(d) List contains 86 stream segments. The impairments include violations of the standards for Aquatic Life, Recreation, and Fish Consumption. The specific water quality impairments are as follows:

- Bacteriological (e. coli or fecal coliform) (140 segments)
- Benthic macroinvertebrates (20 segments)
- pH (17 segments)
- Water temperature (3 segments)
- Mercury in fish tissue (3 segments)
- Dissolved oxygen (2 segments)
- PCB in fish tissue (1 segment)

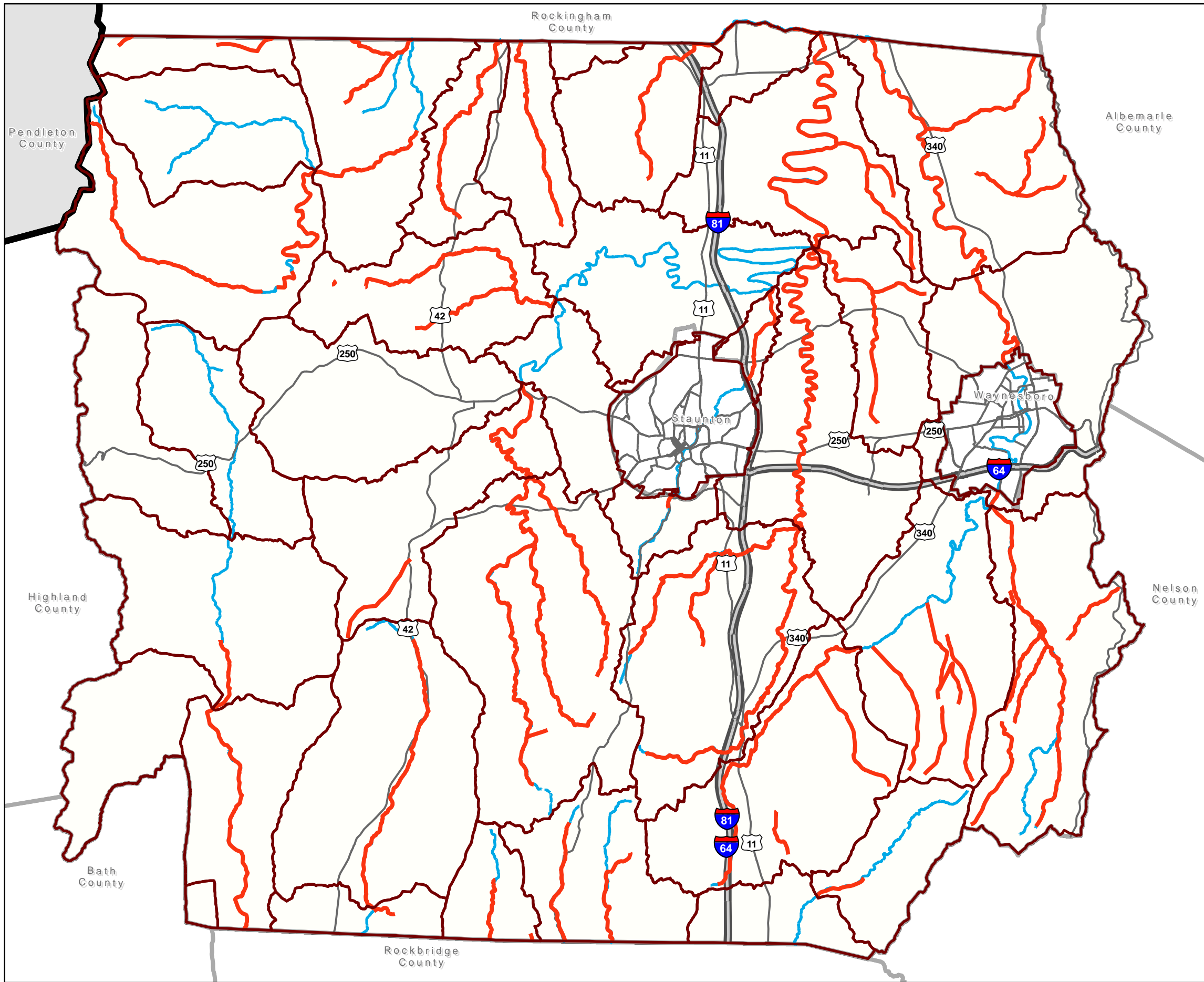
Map 24 shows the 2006 Impaired Stream Segments identified by DEQ.

The Chesapeake Bay Program clean-up is being implemented in Virginia through various river basin tributary strategies. These strategies attempt to quantify nutrient load reductions needed to clean up the Chesapeake Bay, and the Best Management Practices (BMPs) required to achieve these reductions. Augusta County is part of the Shenandoah & Potomac Tributary Strategy¹⁷. This plan recommends a suite of agricultural, urban, open space, forest, and septic management practices. Based on discussions with DCR's Shenandoah River Watershed Coordinator, the following BMPs should be considered priorities for Augusta County:

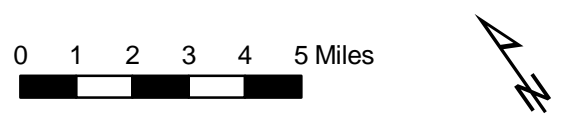
- Riparian buffers
- Mitigate impacts from impervious surfaces through stormwater management and protection of open space
- Preserve farmland to reduce overall impervious cover
- Septic maintenance
- Preserve natural waterways in subdivisions, including greenways (recreation trails)
- Protect groundwater in karst areas
- Enforce the Erosion & Sediment Control Ordinance

Another surface water issue facing the county is incidents of fish kills in the Shenandoah River and the North and South Forks. During the Spring of 2005, up

¹⁷ Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy for the Shenandoah and Potomac River Basins, Commonwealth of Virginia, 2005.



- Legend**
- HUC 12
 - 2006 Impaired Streams
 - Hydrology
 - Roads - Interstate
 - Roads - Primary



Supplemental Natural
Resources Section
Map 24
2006 Impaired Streams

Augusta County
Comprehensive Plan
2007-2027



to 80% of adult smallmouth bass and redbreast sunfish died in the South Fork, and a similar fish kill occurred in the North Fork in 2004¹⁸.

A Virginia Fish Kill Task Force has been working on identifying the causes of the fish kills and investigating water quality and fish health in the Shenandoah, North and South Forks, and Cowpasture rivers. The task force is headed by the Department of Environmental Quality (DEQ) and Department of Game & Inland Fisheries (VDGIF).

D. Demographics and Socioeconomics

1. Population Change

Between 1990 and 2000, at a time when the state population grew by 14.4 percent, Augusta County and the cities of Staunton and Waynesboro experienced a combined increase of 11,301 persons for a net gain of 11.6 percent. In 1990, the area's population accounted for about 1.6 percent of the state's total population; in 2000, the area's population of 108,988 made up about 1.5 percent of the state's total population of 7,078,515.

Area population has continued to grow over the last 40 years. The 11.6 percent growth rate for the decade 1990-2000 was the largest increase since the decade 1960-1970. Most of the growth in the last decade occurred in Augusta County, which had a 20 percent increase. Between 1980 and 1990, Augusta County had only a 1.76 percent increase; however, this low growth rate for that period is misleading because of annexations of county land by both Staunton and Waynesboro. Without the 6,154 former county residents brought into city limits through annexation, the county population would have increased by 13.2 percent.

In 1994, Augusta County produced population growth forecasts that predicted between 7.5 percent and 12.1 percent growth by 1999. These forecasts proved to be lower than the actual growth that occurred. Between 1990 and 1999, the Census showed 18.6 percent growth in the county, a higher rate of growth than experienced by the state in the same period (14.3 percent). Population change varied significantly among census tracts ranging from population loss to 45 percent growth. Between 2000 and 2003, Augusta County grew by an additional 1,812 people. By 2004, Augusta County's population was 68,774 (according to Census estimates), marking a 25.8 percent increase since 1990. However, the county experienced only a 4.8 percent increase in population from 2000 to 2004, an average of 1.16 percent per year.

Augusta County is growing at a rate nearly two and a half times that of Waynesboro and nearly ten times that of Staunton. The population of Staunton decreased by 2.5 percent and Waynesboro's population grew by only 5.2 percent from 1990 to 2000. In 1990, Augusta County accounted for 53.8 percent of the

¹⁸ Update on Virginia Fish Kill Task Force Investigation/Studies Will Focus on Evaluating Water Quality and Health of Fish, Press Release, Virginia Department of Environmental Quality, 2006.