

Chapter 2: Natural Environment

While the sections on government structure, land use and community facilities are primarily concerned with the man-made or “built environment,” this section focuses on the natural environment of the County. Obviously, the natural environment and the man-made environment are closely related. The natural environment has played an important role in shaping the present land use patterns in the County and should continue to be a major determinant of land use patterns in the future.

In past years, man’s disregard of the natural environment has produced a number of dramatic, tragic and uneconomical results such as polluted waters, smog, costly flooding, decreased wildlife and fish production and millions of tons of soil lost through erosion. As a result of these problems, man is gaining a new respect for and knowledge of the natural environment and is learning to plan and design within nature’s framework. A thorough understanding of the elements of climate, topography, geology, soils, water resources, forest resources and wildlife resources is necessary in order to develop environmentally sound plans and should provide the basis for future planning in Rockbridge County. While many of these data sources for the County are not as complete or current as we might wish, they should nevertheless be utilized as fully as possible while recognizing their respective limitations.

CLIMATE

Located at the 38th parallel of latitude, Rockbridge County experiences a temperate climate with cold but not severe winters and generally warm summers. Topography and elevation are the major factors controlling the climate, in addition to latitude and longitude on the North American Continent. The official weather station at Virginia Military Institute in Lexington is no longer in operation and climate data for this area is now obtained from several nearby automated stations.

The annual mean temperature for Rockbridge County varies slightly from year to year but averages about 55°F. Seasonal mean temperatures are 36°F for winter, 54°F for spring, 73°F for summer and 56°F for fall. The highest official temperature ever recorded in the County was 105°F on July 22, 1930, while the lowest official temperature ever recorded was -16°F on January 14, 1912, and again on February 5, 1996. The growing season, defined as the period between the average date of the last freezing temperature in spring (April 26) and the average date of the first freezing temperatures in fall (October 12) is 168 days. However, freezing temperatures and vegetation killing in spring have occurred as late as June 21 and as early in fall as October 4. Specific data concerning mean temperatures for the Lexington area are given in Table 2.1.

Table 2.1 Mean Temperatures, Lexington, Virginia

Month	Daily Maximum (°F)	Daily Minimum (°F)	Monthly Average (°F)
January	45.8	24.3	35.1
February	48.4	25.2	36.8
March	57.9	32.4	45.2
April	68.3	40.7	54.5
May	76.6	50.1	63.4
June	83.3	58.6	71.0
July	86.4	62.8	74.6
August	85.3	61.8	73.6
September	79.6	54.9	67.3
October	69.2	42.7	56.0
November	58.0	33.0	45.5
December	47.9	25.9	36.9

Source: Southeast Regional Climate Center, <http://www.sercc.com>, Period of record 1889 to 2015.

Precipitation in Rockbridge County averages 38.7 inches annually, 2.3 inches of which is attributable to snowfall (equivalent to 23 inches of snow). Precipitation is fairly well distributed throughout the year, with the maximum occurring during the summer months and minimum occurring during the winter months. Monthly mean rainfall is generally two to three inches during the winter months and three to four inches during the summer months. The maximum monthly precipitation on record is 16.99 inches for the month of June, 1995. Snowfall averages 18.4 inches per year, but the historical record shows that snowfall in each of the winter months can reach 20 to 30 inches. A record daily snowfall of 40 inches occurred on January 30, 1901. Average monthly precipitation and snowfall for Lexington are given in Table 2.2.

Table 2.2 Precipitation Totals, Lexington, Virginia

Month	Average Total Precipitation (Inches)	Average Total Snowfall (Inches)
January	2.85	5.2
February	2.72	5.1
March	3.51	3.0
April	3.03	0.2
May	3.51	0.0
June	3.75	0.0
July	3.95	0.0
August	3.53	0.0
September	3.20	0.0
October	2.97	0.0
November	2.75	0.6
December	2.97	4.1
Annual	38.75	18.2

Source: Southeast Regional Climate Center, <http://www.sercc.com>, Period of record 1889-2015.

Prevailing winds in Rockbridge County are primarily from the southwest but during the cold months, winds frequently come from the northwest. Relative humidity varies inversely with temperature, being high in the morning and low in the afternoon. Cloudiness is least in the fall, averaging around five-tenths coverage and greatest in winter with over six-tenths coverage. Partly cloudy days are most frequent in summer with close to 45 percent of the days in this category.

There are three general types of storms that affect Rockbridge County, namely continental, coastal and frontal storms. Continental storms originate over the northwestern or central portion of the United States. They generally move easterly across the country to the Appalachian Mountains which tend to stall them. Continental storms are not limited to any particular season or month. Coastal storms are generally tropical hurricanes which originate in the South Atlantic or Western Caribbean, primarily in spring and fall, and move northward along the eastern seaboard states. In recent years, western Virginia has experienced three severe tropical storms, Hurricane Camille in August 1969, Hurricane Agnes in June 1972 and Hurricane Isabel in September 2003. These storms caused extensive local flooding. Finally, frontal storms occur when warm moist air coming up from the Gulf of Mexico encounters cold dry air masses coming

down out of Canada. The line of contact between these two air masses, known as a front, is a region of unstable atmospheric conditions. The warm moist air from the Gulf is lofted above the cold air, causing precipitation to condense and fall. Fronts generally approach the County from the west or southwest. Torrential rain from such a slow moving, low-pressure system caused catastrophic flooding in the County in November, 1985.

Air Quality

The Virginia Department of Environmental Quality (DEQ) has divided the State into six regions for handling air, water and waste issues. Rockbridge County occupies the southern portion of the Valley Region and is administered by the DEQ's Harrisonburg office. In spite of the fact that the DEQ maintains no air sampling stations in the County, the agency considers the air quality in the County to be very good. This conclusion is based on comparison of air quality in the other regions of the State and the fact that Rockbridge County is quite rural, has a low population and little in the way of polluting industries.

Some factual data on air quality are, however, available. The USDA Forest Service seasonally monitors air quality at the Natural Bridge Ranger Station measuring a number of parameters including ozone and particulate matter. Ozone formed by a complex series of reactions among nitrogen oxides and organic compounds under the influence of sunlight, produces smog and is a pulmonary irritant that affects respiratory functions. Most of the ozone pollution comes from cars. The health-based air quality standard is limited to 75 parts per billion measured over eight hours. One exceedance of the ozone standard was detected at the Natural Bridge station during 2008, but none during 2009, 2010 and 2011.

Particulate matter with a diameter of less than or equal to 10 microns (PM10) can affect the human respiratory systems and cause lung ailments and asthma. In 1997 this standard was lowered to 2.5 micron (PM2.5). The standard for PM10 is 150 microns and that of PM2.5 is 35 microns, both as a 24-hour average. At the Natural Bridge station in the period 2005 to 2010, PM10 levels were about 15 micron and PM2.5 levels were in the 10 to 15 micron range, all well below the mandated standards. The DEQ operated a particulate monitoring station at Central Elementary School in Lexington from October, 2008 to September, 2009. Values for PM10 reached 25.0 microns in September 2009, and at all other times were well below the standard of 150 microns.

Aside from ozone and particulate matter, other potential pollutants of concern in the region are mercury and acid rain. Mercury in the air is produced by coal-burning power plants as well as hazardous waste incinerators and certain industrial facilities such as paper manufacturing plants. Mercury can be directly deposited in surface waters or deposited in forested areas where runoff can eventually discharge mercury to streams and lakes. Human exposure to mercury is linked to consumption of fish from contaminated surface waters. The DEQ is in the process of evaluating mercury deposition state-wide and has initiated a new inventory of point sources of mercury generation that will be used to prepare an air quality modeling study.

The sources of mercury deposition in Virginia are both regional and local. According to the DEQ 2002 point source inventory, there are two industries in the region that emit mercury. Mead Westvaco in Covington emitted 27 lbs/yr and Mohawk Industries-Lees Carpets in Glasgow emitted 7.5 lbs/yr. At the present time the, DEQ has issued no mercury fish consumption advisories for Rockbridge County.

Acid rain in Virginia, caused by emissions of coal burning power-generating plants in Ohio and West Virginia, damages the environment by acidifying lakes, streams and aquatic life. Acid rain also affects forest productivity and can damage crops. Pristine rivers in the Blue Ridge Mountains and the George Washington National Forest have suffered from dramatic losses of aquatic insects and trout. Acid rain research in the region is carried out by the University of Virginia's Department of Environmental Sciences. Although considerable reduction of air-borne pollution by industrial facilities has been achieved in recent years, the acid rain problem will continue in the foreseeable future.

Analysis of the air pollution data for the area reveals two rather interesting trends. The highest levels of particulate matter and ozone air pollution consistently occur during summer months, while the lowest generally occurs during the winter months. The greatest constant source of air pollution in the County is exhaust from vehicular traffic in the I-81 and I-64 corridors. Motor vehicle traffic on these roadways is considerable and can be expected to increase further in the coming years.

Stagnant Air Conditions

From time to time, Rockbridge County experiences unusual climatic conditions which cause air quality problems in the area. During summer and early fall, the County is often under the influence of the Bermuda high pressure system, a very large, slow moving, warm air mass that generally has very weak winds of less than seven miles per hour. Winds of this strength do not create enough turbulence to mix the atmosphere. In addition, the atmospheric conditions present in the Bermuda high pressure system tends to encourage the formation of thermal inversions. In a thermal inversion, the normal atmospheric condition is reversed, and instead of an air mass becoming cooler with each 1,000 foot rise in altitude, it becomes warmer. In such a situation where warm air overlies cooler air, convection currents cannot form because the cooler air is denser and will not rise through the warm air. For this reason, thermal inversions prevent vertical mixing of the atmosphere.

As a result, during summer and early fall these two factors, weak winds and thermal inversions, often combine to effectively inhibit normal mixing of the atmosphere in Rockbridge County, resulting in stagnant air conditions. The problem is aggravated by the topography of the region. The valleys tend to act as catch basins during stagnant air periods, accumulating and holding the polluted air. The weak prevailing winds are not strong enough to disperse the stagnant air mass, but they do tend to push the stagnant air eastward against the Blue Ridge Mountains. The result is that pollution levels are frequently higher in the eastern part of the County.

Stagnant air periods generally last four or five days before being cleared out by a storm system. If large amounts of pollution are generated during stagnant air periods the pollution is not dispersed but instead accumulates in the lower levels of the atmosphere where it may build up to near dangerous levels.

At the present time, the problem of pollution during stagnant air periods in Rockbridge County is not critical. This problem has become critical in other areas however, and according to the National Atlas of the United States, Rockbridge County lies within one of the two major regions in the country where high air pollution potential is forecast in the future. It seems important that any consideration of new development in the County should be carefully analyzed in order to determine the potential impact on air quality.

Climate Change

There is very strong scientific evidence that climate change is a world-wide phenomenon that affects people in all regions, including Virginia and Rockbridge County. Emissions of so-called greenhouse gasses that trap heat in the atmosphere are responsible for a slowly rising global temperature. Included in those gases are carbon dioxide (CO₂) derived from the burning of fossil fuels, methane (CH₄) emissions from livestock and decay of organic waste in landfills, nitrous oxide (N₂O) from industrial and agricultural activities and synthetic gases found in certain appliances. Of these gases CO₂ is by far the most significant. In the United States CO₂ represents some 85 percent of total greenhouse gases.

Examination of long-term weather records for the region does not show clear evidence of a warming trend, although the region has experienced some unusual weather extremes in recent times. The effects of a warming climate to be expected in future years will probably show itself as a slow rise in seasonal temperatures and more frequent and severe weather events such as storms, droughts and periods of excessive precipitation. A warmer climate may result in increased extreme weather events that could adversely affect agriculture and cause economic losses. Sufficient justification exists for the County to promote measures to reduce emissions of CO₂ and increase energy efficiency in buildings and homes.

TOPOGRAPHY

Rockbridge County is located at the southern end of the Shenandoah Valley of Virginia and is flanked by the Blue Ridge Mountains to the east and the Allegheny Mountains to the west. In form, Rockbridge is an irregular rectangle, the longer direction trending northeast-southwest parallel to the mountain ranges. The length of the County is nearly 32 miles, and the width at the widest point is nearly 26 miles. The County covers an area of approximately 607 square miles. Topographic maps on a scale of 1:24,000 (one inch equals 2,000 feet) are available for the entire County at <http://topomaps.usgs.gov/>.

The County's eastern boundary winds for 40 miles along the crest of the Blue Ridge Mountains, forming a natural geographic line. The western boundary of the County is more segmented, following the crests of several separate mountains. The line starts northward along Camp

Mountain, passes to North Mountain, and then to Mill Mountain. The lines that connect the boundary from mountain crest to mountain crest coincide with natural stream valley divides, thereby making the western boundary a natural geographic line also. The northern and southern boundaries are both straight lines, entirely artificial.

As mentioned, the Great Valley of Virginia trends northeast-southwest through the central portion of Rockbridge County. The Valley is approximately 11 miles wide at the northern border of the county, 14 miles wide in the central portion of the County near Lexington and less than 5 miles wide at the southern border of the County. Land in the Valley ranges from gently rolling to hilly and steep. Elevations range anywhere from 800 feet to over 3,500 feet. As seen on the general elevation map in Map 2.1, the highest elevations in the Valley, around 2,000 feet, are found along the northern boundary of the County near the drainage divide between the James River Basin and the Shenandoah River Basin. The elevation of several hills near Raphine reaches 2,080 feet. The lowest elevations in the Valley are found in the southern portion of the County, primarily along the James and Maury Rivers. The lowest point in the entire County is located near Glasgow, where the James River flows out of the County. The elevation at this point is only 720 feet above sea level.

To the east of the valley are the Blue Ridge Mountains, which occur in a narrow band along the entire eastern edge of the County. The highest elevation of the Blue Ridge within the boundaries of the County appears to be Thunder Ridge, which is located in the extreme southern corner of the County and which has an elevation of 3,683 feet. Bluff Mountain, just south of Buena Vista, is probably the second highest point in the Blue Ridge portion of the County, with an elevation of 3,372 feet.

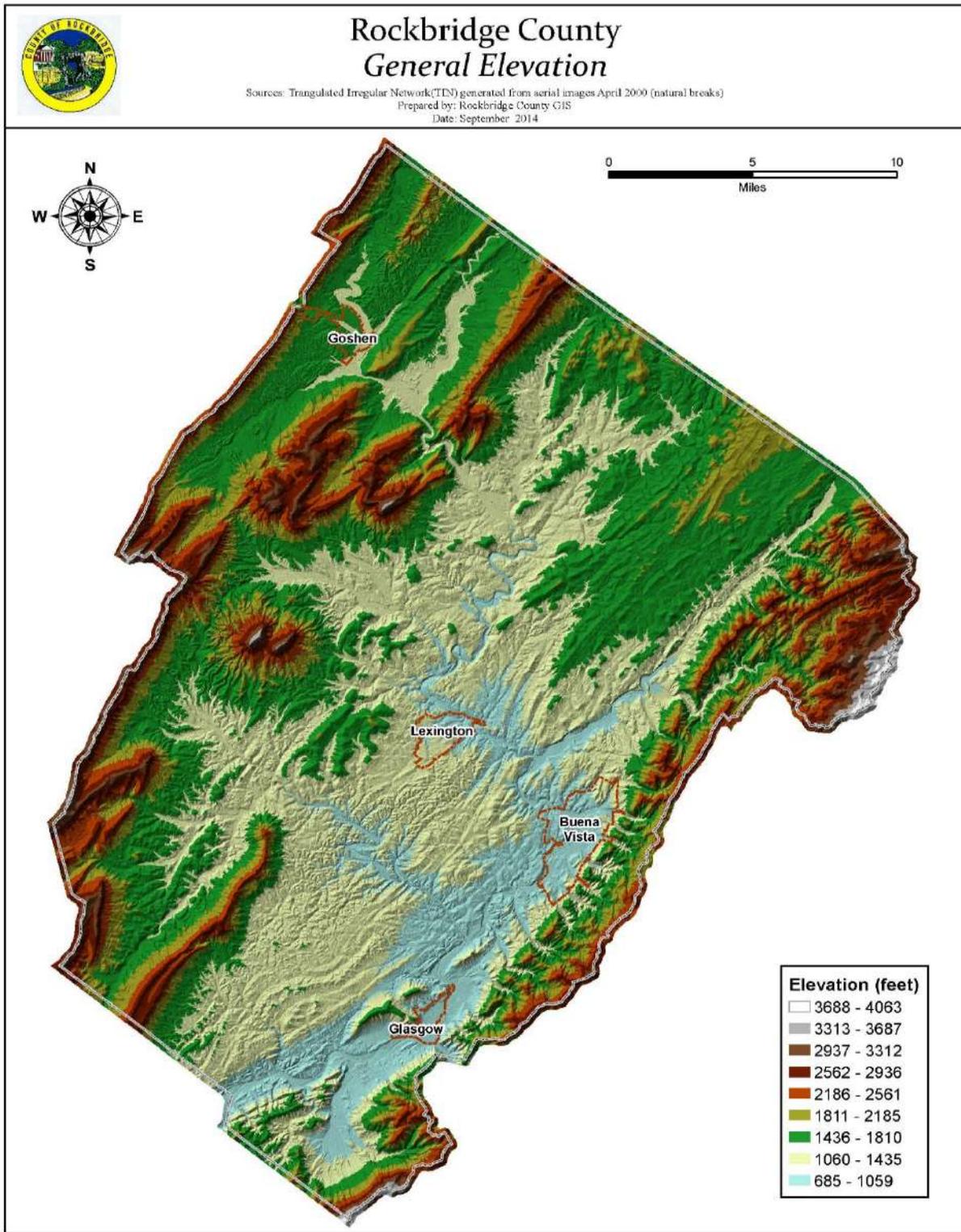
The Blue Ridge rises from the valley floor as a series of low foothills which rapidly give way to a line of sharply pointed mountains known as knobs. These knobs are very well developed in the vicinity of Buena Vista. Beyond the knobs are the higher interior ridges of the mountain range. The Blue Ridge has several deep, narrow mountain valleys, including Irish Creek Valley, Little Mary Valley and Arnold's Valley. The James River has cut through the Blue Ridge chain near Glasgow, forming the scenic James River Gorge.

To the west of the valley are the Allegheny Mountains, a series of alternating ridges and valleys which also trend northeast-southwest. The ridges are fairly straight, narrow and well defined. The valleys are also fairly straight but not quite so narrow. The ridges in the Allegheny generally approach 3,000 feet in elevation. Big House Mountain, with an elevation of 3,645 feet, is probably the highest elevation in the Allegheny sector of Rockbridge County.

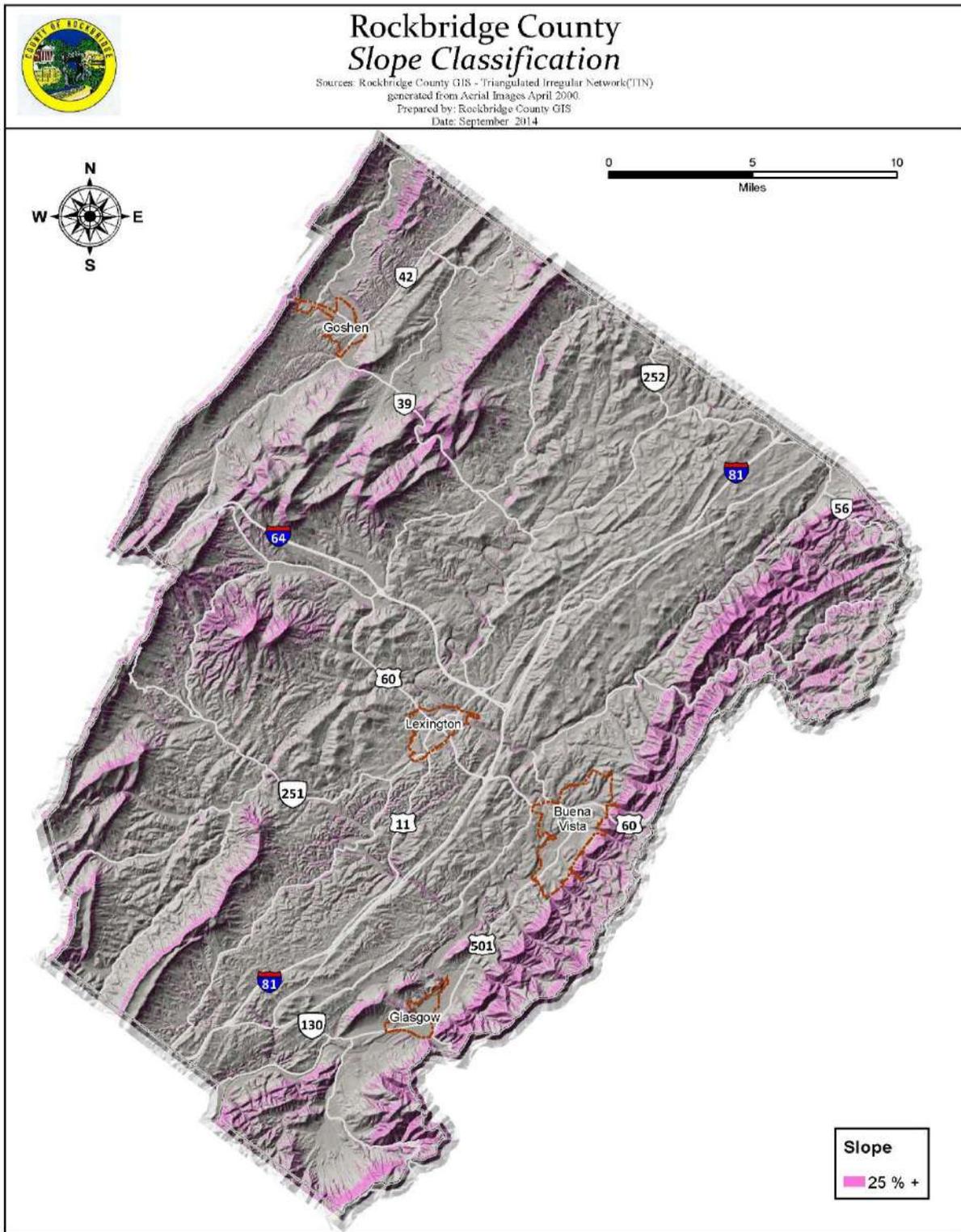
The mountainous topography, which is evident throughout much of Rockbridge County, presents a number of serious limitations to development. Even in terms of small-scale development, project as well as environmental costs can be directly related to topography. Excessive slopes impose high costs on development by increasing both building and public utility costs. Excessive slopes also may require large lot sizes in order to properly site structures, to grade for adequate drainage or to provide adequate space for sewage drain fields. In addition, building on such

slopes introduces a number of environmental costs related to increased soil erosion and stream sedimentation. There also exists the potential hazard of down slope movement of unstable soil or rock resulting from development on steep slopes. See Map 2.2.

Map 2.1



Map 2.2



The following represents a useful guide when considering the limitations of slope on development:

0-8 Percent – Level Land: This is flat to moderately sloping land imposing no slope limitations on development. However, areas subject to periodic flooding or poor drainage may be found within this category.

9-16 Percent – Rolling Land: This category has few limitations for small concentrations of residential, commercial, and industrial activities not requiring extensive amounts of level ground. However, development on large tracts of this land for such uses is more limited due to grading costs. This category imposes no slope limitations on pastures, forage crops, orchards, and forest uses.

17-24 Percent – Hilly Land: This land is suitable for residential uses if planning for site development includes consideration of the topography. However, hilly land generally makes the construction of water and sewer facilities economically unfeasible. This category imposes no slope limitations on pastures, orchards and forest uses.

25 Percent and Over – Steep Slopes: Due to slope limitations, this land, in general, is considered unsuitable for any type of intensive development or cultivation. Utilizing conservation practices, the land in this category can be used for outdoor recreation, wildlife management, watershed protection and forest uses. Map 2.2 illustrates areas of Rockbridge County with slopes exceeding 25 percent.

GEOLOGY

Rockbridge County is located in the central portion of the Appalachian Mountain Chain. As mentioned earlier, the eastern edge of the County lies in the Blue Ridge Physiographic Province, the central portion is part of the Great Valley of Virginia and the ridges of the Valley and Ridge Province lie in the western section of the County. Each of these three sections is characterized by distinct land forms and soils that are closely related to the types of rocks and the configuration (structure) of rocks that underlie them. Landform, soils and geology have been major factors in the past development of the region, and they should be carefully considered in planning for future development.

Detailed geologic maps on a scale of 1:24,000 have been published by the Virginia Department of Mines, Minerals and Energy (DMME) and cover most of Rockbridge County. Draft or preliminary geologic maps are available for the remaining areas. Although this kind of detailed information is needed by engineers, well drillers, contractors and others in order to make sound designs of dams, buildings, highways, etc., the development of a general land use plan requires less specific information. Very useful for planning purposes is the new geologic map of the County on a scale of 1:50,000 by Wilkes, Spencer, Evans and Campbell published by the DMME in 2007. This map contains a list and description of the various rock units. A simplified

geologic map of the County showing major rock types is found in Map 2.3. Table 2.3 represents the stratigraphic column and the various formations.

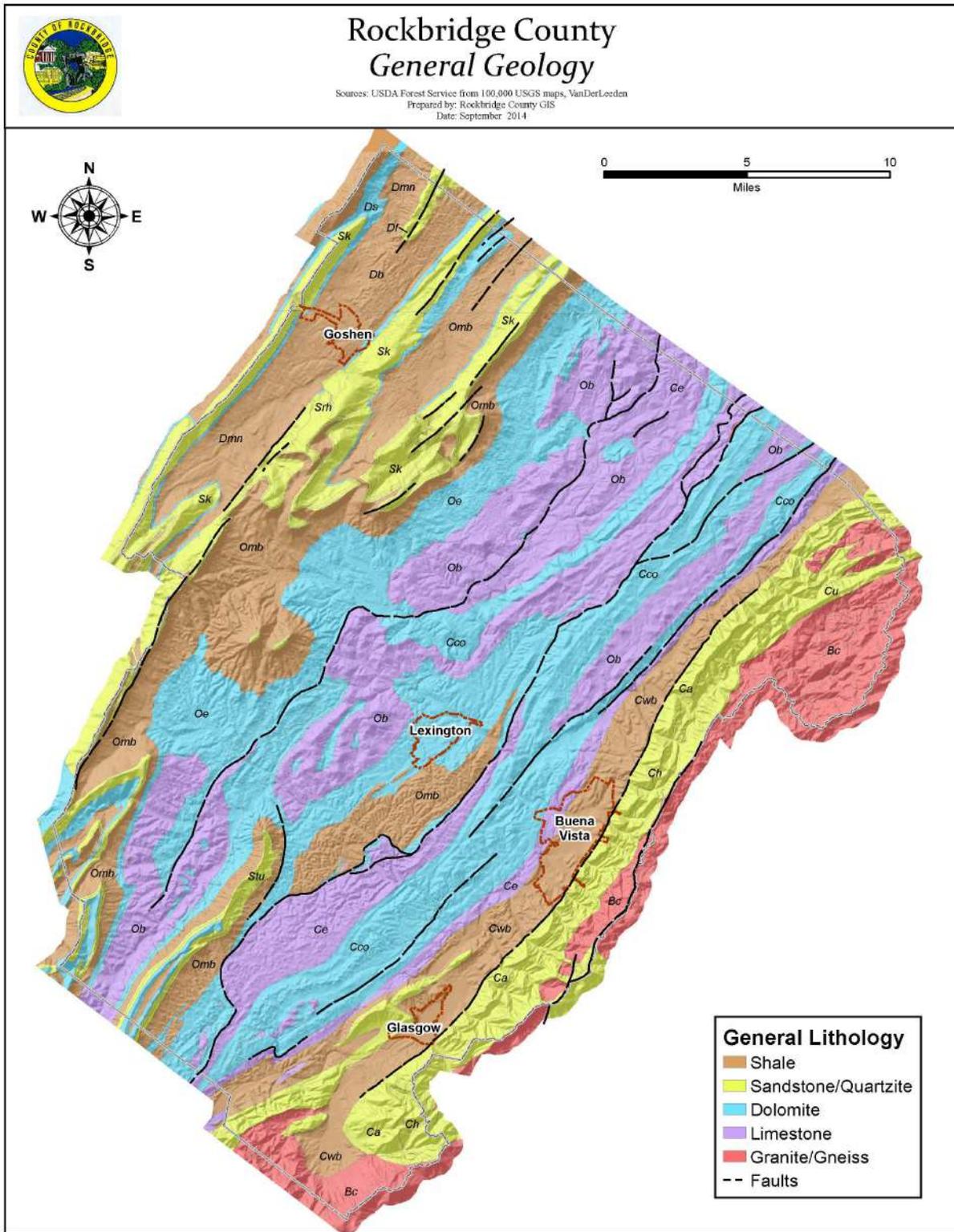
Table 2.3 Stratigraphy of Geologic Units in Rockbridge County

Age	Formation & Map Symbol	Thickness (ft)	Predominant Lithology
Quaternary	Alluvium and Colluvium (Qal)	0-200	Cobbles, gravel, sand, silt, clay
Devonian	Foreknobs (Df)	3,000	Sandstone, siltstone, shale
	Braillier (Db)	1,500-2,200	Shale
	Millboro Shale & Needmore (Dmn)	1,000-1,500	Shale
Lower Devonian	Oriskany Sandstone (DS)	20	Sandstone
Upper Silurian	Licking Creek Limestone (DS)	50-130	Limestone
	Healing Springs Limestone (DS)	5-90	Limestone
	New Creek Limestone (DS)	20-60	Limestone
	Keyser Limestone (DS)	80-120	Limestone
	Clifton Forge Sandstone (DS)		Sandstone
	Tonoloway Limestone (DS)	100-200	Limestone
Silurian	Keefer Sandston (Sk)	200-350	Sandstone
	Wills Creek	0-80	Shale
	McKenzie	0-50	Sandstone, limestone
	Bloomsburg	0-70	Sandstone, shale
	Williamsport Sandstone	0-70	Sandstone
	Rose Hill (Srh)	200-250	Sandstone
	Tuscarora (Stu)	50-250	Sandstone
Ordovician	Juniata (Oj)	300	Sandstone, shale
	Martinsburg (Omb)	1,500	Shale, sandstone, limestone
	Edinburg (Oe)	800-1,250	Limestone, shale (sinkholes)
	Middle Ordovician Undivided (Omu)	100-400	Limestone
	Lincolnshire (Oln) and		
	New Market Limestone (Oln)	100-500	Limestone
	Beekmantown (Ob)	1,500-2,000	Dolomite (sinkholes)

	Stonehenge (Ost)	300-500	Limestone (sinkholes)
Cambrian	Conococheague (Cco)	2,000-2,500	Limestone, sandstone, dolostone (sinkholes)
	Elbrook Formation (Ce)	1,300-2,300	Dolomite
	Waynesboro Formation (Cwb)	1,200-2,000	Shale, limestone, dolomite
	Shady Dolomite (Cs)	1,200	Dolomite (sinkholes)
	Chilhowee Group:		
	Antietam Formation (Ca)	400-600	Quartzite, sandstone
	Harpers Formation (Ch)	200-1,000	Siltstone, shale, sandstone, quartzite
	Unicoi Formation (Cu)	500	Conglomerate, sandstone, quartzite
Cambrian & Precambrian	Blue Ridge Basement Complex (Bc)	Unknown	Granite, gneiss, basalt

Source: van der Leeden, 2004

Map 2.3



The Blue Ridge Province

The Blue Ridge Province lies along the eastern border of Rockbridge County. The core of the Blue Ridge Province is composed of very old igneous and metamorphic rocks including gneisses, granites and granodiorites. These rocks, which are known as the Virginia Blue Ridge complex, are very hard and resistant to erosion.

The remainder of the Blue Ridge Province is underlain by metamorphosed late Precambrian lavas and sedimentary rocks, predominantly sandstones, quartzites, shales and conglomerates of Cambrian age. These rocks, known as the Chilhowie Group, are also hard and resistant to erosion. They are exposed along the western slopes of the Blue Ridge, the entire length of the County. The Chilhowie Group is an important source of groundwater for the City of Buena Vista.

The Great Valley of Virginia

Most of the productive farmland and most of the past development in Rockbridge County is found in the valley portion of the County. This area, characterized by low, hilly terrain and several ridges with moderate relief, is underlain by a thick (10,000 feet plus) section of limestones and dolostones with some shale and with minor amounts of sandstone and chert. The structure of the rocks in the valley is complex; the rock layers have been deformed into folds of various sizes and broken by a number of important fault zones. None of the faults are presently active. Since the carbonate rocks of the Valley are soluble in rainwater, they erode relatively fast compared to the resistant rocks of the Blue Ridge. For this reason, the Valley stands topographically lower. The steepest slopes in the Valley generally occur along streams which have become deeply entrenched in the topography and around some hills and ridges such as Brushy Hill and Mount Atlas which are capped by more resistant chert that has eroded out of dolostones.

Valley and Ridge

Ridges that are part of the Valley and Ridge Province include House Mountain, Hogback, Short Hill, North Mountain and Jump Mountain. This area is characterized by a succession of northeast trending ridges and valleys. The rocks in this section are younger (Upper Ordovician, Silurian and Devonian age) than the rocks of the Great Valley. The most prominent parts of the rock sequence in this western area are the sandstones and quartzites which have an aggregate thickness of several hundred feet. Because of their resistance to weathering and erosion, these rocks hold up the ridges, while the intervening valleys contain more readily eroded shales and limestone. The limestone section is thin (a few hundred feet) compared with that of the Great Valley, which is thousands of feet thick.

Mineral Resources

A number of mineral resources have been produced from the Rockbridge area, chiefly in the latter part of the 1800's and the early part of the 1900's. The history, mode of occurrence and further possibilities of the County's mineral resources are noted in the following sections.

Iron Ore

The major iron ore deposits of the area have been found along the western slopes of the Blue Ridge. These deposits are part of the limonite belt that extends the length of the Blue Ridge in Virginia. The ores of the Blue Ridge belt are primarily limonite; they contain approximately 35 to 50 percent metallic iron. The deposits are residual accumulations derived from weathering of the Lower Cambrian rocks. Mines have been worked in material overlying the Erwin quartzite, Shady dolomite, Rome formations and in breccias found along the Blue Ridge fault in Arnolds Valley.

In the western part of the County, iron ore has been mined from two separate sources. Residual limonite deposits associated with the Oriskany sandstone (also known as the Ridgeley sandstone) have been derived from a number of locations along the slopes of the Allegheny Mountains. Iron has also been derived from the hematitic beds which make up the Cacapon Formation.

There are no active iron mines in Rockbridge County at the present time. Additional deposits of iron in the County are likely to be small, isolated and difficult to locate. In addition, deposits are not likely to be of high enough grade to be mined economically at this time.

Manganese Ore

Manganese ore deposits have been found in conjunction with the iron deposits of the Blue Ridge Belt and in conjunction with the Oriskany iron deposits. The majority of the manganese production came from the Blue Ridge Belt. The ore consisted of nodular masses of pyrolusite, psilomelane, manganite and wad (bog manganese) which occurred in the residual soils at the foot of the Blue Ridge.

As with iron, additional deposits of manganese ore are likely to be small, isolated, and difficult to locate. In addition, deposits are probably not of high enough grade to be mined economically at the present time.

Tin Ore

Tin mineralization occurs in Panther Hollow, in the Irish Creek area. The ore is derived from the Pedlar Formation and intermittent attempts at mining have yielded a small amount of tin ore. The mine is not operating at the present time.

Carbonate Rocks

The entire region between the Blue Ridge and Little North Mountains is largely underlain by carbonate rocks of varied types. The carbonate rocks of the area may be divided into four major groups based on chemical composition. The New Market limestone is included in the high calcium limestones (over 95 percent calcium carbonate). These limestones are used in industry for the manufacture of fertilizers, dye, fluxes, glass, lime, mineral feeds, paper, Portland cement and many other products.

The Edinburg formation and most of the Tonoloway and Helderberg rocks are included in the limestones (chiefly calcium carbonate, less than 10 percent magnesium carbonate) and impure limestones (more than 5 percent noncarbonated material). The Conococheague and Chepultepec

limestones contain many rocks of this classification but also much magnesian limestone and dolomite that would have to be separated. These limestones are used for the manufacture of agricultural limestone, explosives, natural cement, hydraulic lime and many other products.

The Elbrook and Beekmantown formations and large parts of the Conococheague and Chepultepec limestones are included in the magnesian limestones (10 to 30 percent magnesium carbonate) and dolomites. These rocks may be used as agricultural limestone, in explosives manufacture, as blast furnace flux and for many other purposes.

The Shady dolomite is the only example of the fourth category, high-magnesium dolomite (over 40 percent magnesium carbonate and less than 4 percent noncarbonated material). This rock type is used for the manufacture of dolomite refractories, dye, fertilizers, paper and many other products. It is not presently mined in Rockbridge County.

In addition to industrial uses, the carbonates in Rockbridge County have been mined as aggregate for use in highway construction. The main obstacle to development of carbonate rocks as a major mineral resource is the distance from a sizable market.

Clay and Shale

Clay and shale are used primarily in the manufacture of brick, tile, pottery and stoneware. The most extensive clay deposits in the County are found below the alluvium on the west slopes of the Blue Ridge where the Shady and Rome formations are deeply weathered. Clay from this source has been used as filler in the manufacture of paper, paint and rubber, and was used in the manufacture of brick near Glasgow. Recent stream clays are scattered throughout the County and have also been mined in the past. Testing by the Virginia Division of Mineral Resources indicates that shale from the Martinsburg, Millboro and Brallier formations is also potentially suitable for brick, tile and pottery, as well as light-weight aggregate.

Sandstone

The sandstones in Rockbridge County have been used for the manufacture of both crushed stone and silica sand. The most important sources of silica sand are the Erwin quartzite, the Tuscarora sandstone, the Keefer sandstone and the Oriskany sandstone. Although there are no active sand mines in the County, sand was mined from the Oriskany formation near Goshen up until the mid-1970.

Geologic Hazards

Several types of natural hazards related to geology are present in the County. Hazards related to karst topography and steep slopes are the most serious of these. A large number of faults are present but none of these are active. The major faults in Rockbridge County include the Staunton-Pulaski fault, the Little North Mountain fault, the South River fault and the Midvale fault (see Map 2.3).

One problem with development on exposed fault planes stems from the fact that fault planes tend to channel surface water into the ground through the extensive zones of rock breakage. Development on an exposed fault plane, therefore, poses two potential groundwater problems:

(1) impervious ground cover associated with development might prevent a significant amount of water from entering the fault plane and thereby retard the recharge of the groundwater supply; (2) development on a natural recharge area such as a fault plane would tend to channel pollution into the groundwater supply, contaminating the water table of a large region. Obviously, both of these conditions should be avoided.

Another common problem associated with development on faults is the problem of ground instability. The highly fractured and crushed rocks which occur near fault planes do not have the strength or bearing capacity of solid bedrock. Major construction on a fault plane could, therefore, result in slumping or tilting of buildings, foundation failures or, in extreme cases, collapse of the structure. Development in the vicinity of a fault should always be preceded by careful testing of the bearing capacity of the subsurface.

Because of Rockbridge County's location in the Great Valley of Virginia, it is part of one of the largest karst regions in the United States. Karst regions, characterized by caves, sinkholes, sinking creeks and large springs are developed on regions underlain by limestone and dolomite. Limestone and dolomite (dolostone), both being carbonate rocks, are soluble in rain water (weak carbonic acid). Over many thousands to millions of years, rain water working its way down through fractures and joints in the carbonate rock has dissolved passageways and caves of considerable size. When a cave or cavern becomes large, its roof may lack support, resulting in subsidence or collapse. This produces the steep-walled closed depressions on the ground surface known as sinkholes. Once a sinkhole is formed, surface runoff from the immediate surrounding area is channeled into it. This runoff, and any pollutants it may carry, then filters down into the cave passage, where it joins the subsurface water supply. For this reason, trash and other pollutants should not be placed in areas that may drain into a sinkhole.

Karst regions are easily identified by the presence of sinkholes and cave openings on the ground surface. Map 2.4 illustrates the distribution of sinkholes which appear on U.S. Geological Survey 7.5 minute topographic maps, as well as the location of a number of caves in Rockbridge County. As seen from this map, major karst areas are located in the area north of Lexington, in the vicinity of Effinger and Collierstown, Natural Bridge, Buffalo Forge and near the confluence of the South River with the Maury River. While this map delineates the most critical karst areas within the County, it does not, however, define all the problem areas. Any area underlain by carbonate material could show karst features on a small scale.

There are two primary concerns associated with development in karst regions. First, karst regions, which are areas of long-term ground instability, present the potential hazard of surface subsidence or collapse. The specific hazards involved in constructing buildings in karst areas are:

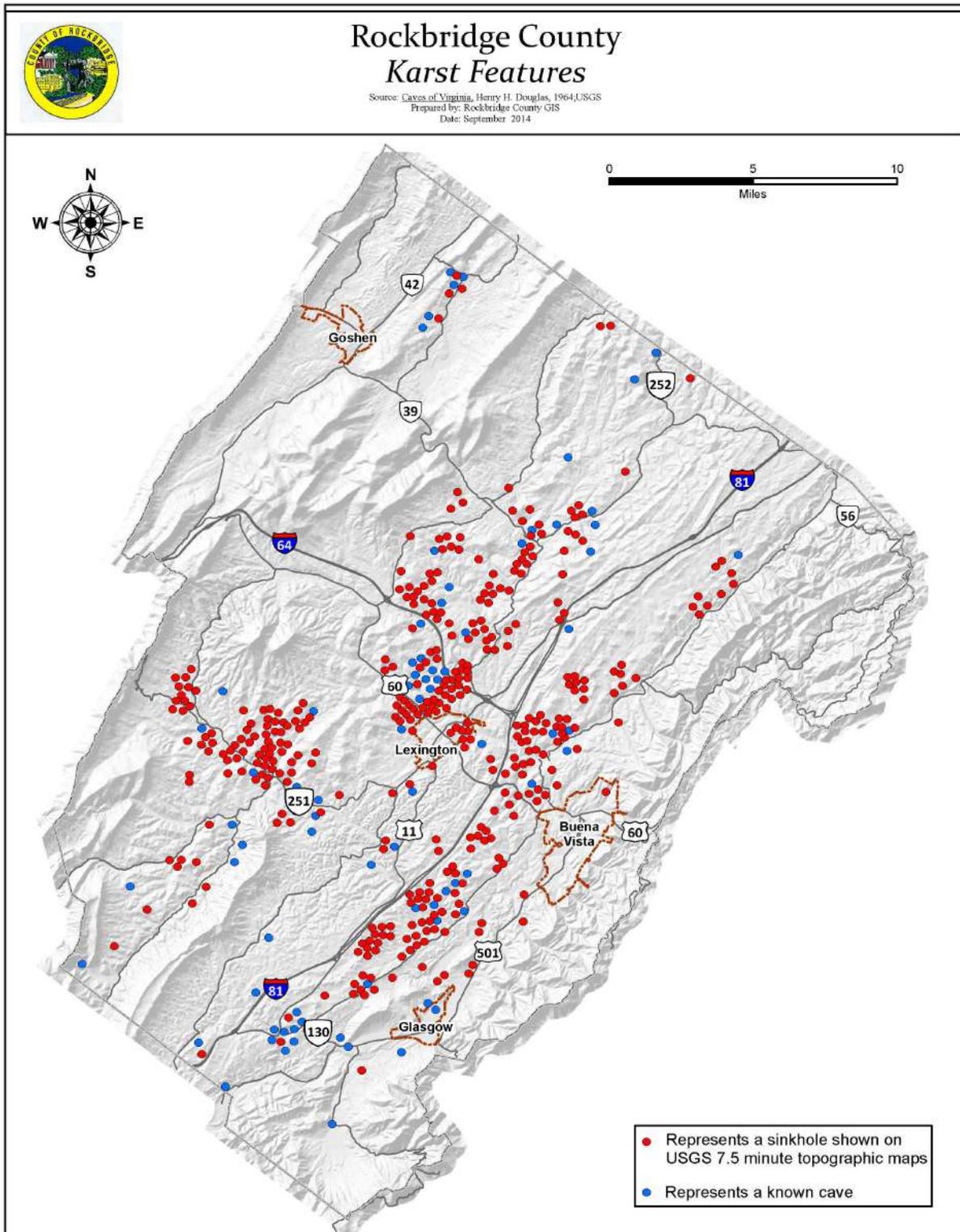
- (a) The weight of a structure may exceed the strength of the rock causing new fractures to form or old ones to move. The result might be a rapid collapse of the ground surface or a gradual subsidence over time.
- (b) The weight of a structure may cause compaction and subsidence of the mixture of rock, clay and soil which generally accumulates in the bottom of a sinkhole. This

- subsidence would probably be uneven across a building causing the foundation to crack.
- (c) The withdrawal of water from aquifers (e.g., by pumping wells) or changing groundwater recharge (by changing surface drainage) may remove part of the support from an uncompacted sinkhole fill resulting in compaction and subsidence.
 - (d) Heavy rains and sudden increases in the amount of water drainage into a sinkhole could induce instability and result in additional subsidence or collapse.

In order to reduce the risk of damage from subsidence or collapse in karst areas, development on existing sinkholes should be avoided completely, and all development should be preceded by test borings to determine the possible presence of hidden cavernous zones.

A second problem with development in karst regions has to do with the quality of the groundwater supply. Sinkholes are prime recharge areas for the groundwater supply of a region. Rain that falls into areas drained by sinkholes is channeled directly and rapidly into the subterranean aquifer. (See section on surface water drainage for an illustration of the areas in the County which are drained by sinkholes.) When development occurs on a recharge area such as a sinkhole field, the probability of pollution entering the groundwater supply is greatly increased. Pollutants from failing septic systems and various chemicals may get into the groundwater through the sinkholes and pass essentially unfiltered into neighboring or even distant wells or springs. In many instances, the movement may be quite rapid. For these reasons, development on karst regions should be closely regulated in order to avoid contaminating aquifers which may serve as water supplies for large numbers of persons.

Map 2.4



SOILS AND SOIL SUITABILITY

The identification and location of various soil types is an essential element in planning the land use of a particular area. Such an analysis determines what special limitations or special capabilities various soils might have, and what the effects of development on various soil types might be. Soil type influences building foundation strength, crop yields, erodibility, drainage and the effectiveness of septic tank wastewater disposal systems. All of these are important in planning the nature and extent of development that should occur within an area.

In general, soils information indicates the land's capability to support a variety of land use activities and provides an analytical tool on which to base planning decisions. By recognizing the different potentialities of various soils and offering guidelines as to their optimum or best use, a great deal can be done to protect both the natural environment and the residents of a particular area. Too often in the past soils have been used inappropriately, resulting in public health and safety hazards such as flooded basements, damaged highways, septic tank failures and mud slides as well as the loss of a valuable natural resource – the soil itself.

Different soils present different limitations to development. The Soil Survey of Rockbridge County contains ratings of soils according to their limitations for various types of development. The primary system online that allows one to access detailed soil survey information, both spatial and tabular, are the Web Soil Survey <http://websoilsurvey.nrcs.usda.gov/> and the Soil Data Mart <http://soildatamart.nrcs.usda.gov/>.

Soil Associations

General soil types in Rockbridge County are shown in the Map 2.5. These soil association groupings were developed from the 1990s field mapping of the county, which is available online. Much of the information from the 1980s survey has been updated with the assistance of the Natural Resources Conservation Service staff in Rockbridge County. The nine general soil associations in Rockbridge County are described below while the characteristics of the various soil types are summarized in Table 2.4.

Table 2.4 Characteristics of the Various Soil Types in Rockbridge County

Soil Series	Slope Range %	Depth to Bedrock	Drainage Class	Saturated Hydraulic Conductivity	Shrink/Swell Potential	pH	Corrosivity Uncoated Steel	Corrosivity Concrete	Erosion Factor
Alonzville	0 to 8	>5'	Well	Moderately High	Low	4.5-6.0	Low	Hi	5
Berks	3 to 70	20 to 40''	Well	Moderately High	Low	4.0-5.5	Low	Hi	2
Botetourt	0 to 3	>5'	Moderately Well	Moderately High	Low	5.1-6.5	Mod	Hi	5
Buckton	0 to 3	>5'	Well	Moderately High	Low	7.0-8.4	Moderate	Moderate	5
Caneyville	3 to 55	20 to 40''	Well	Moderately High	Moderate	4.5-7.3	Hi	Moderate	2
Carbo	3 to 70	20 to 40''	Well	Moderately Low	Hi	5.6-7.8	Hi	Low	2
Chiswell	8 to 55	10 to 20''	Well	Moderately High	Low	4.5-6.0	Moderate	Moderate	2
Cottonbend	3 to 15	>5'	Well	Moderately High	Low	4.5-6.0	Moderate	Hi	4
Coursey	0 to 8	>5'	Moderately Well	Moderately High	Low	4.0-5.5	Moderate	Hi	5
Dekalb	3 to 80	20 to 40''	Excessively	High	Low	3.5-5.5	Low	Hi	2
Derroc	0 to 3	>5'	Well	High	Low	5.6-7.3	Low	Moderate	5

Edneytown	3 to 70	>5'	Well	Moderately High	Low	4.5-5.5	Moderate	High	5
Escatawba	3to 15	>5'	Well	Moderately High	Low	4.5-5.5	High	Moderate	5
Fredrick	3 to 55	>6'	Well	Moderately High	Moderate	4.5-6.0	Moderate	High	5
Gladehill	0 to 3	>5'	Well	High	Low	6.1-7.8	Low	Low	5
Groseclose	0 to 55	>5'	Well	Moderately High	Moderate	4.5-5.5	High	High	5
Holly	0 to 3	>5'	Poorly	Moderately High	Low	5.1-6.5	High	Moderate	5
Ingledove	0 to 3	>5'	Well	Moderately High	Low	5.6-7.3	Low	High	5
Ivongate	0 to 3	>5'	Moderately Well	Moderately High	Low	5.6-7.3	Low	High	5
Laidig	3 to 35	>5'	Well	Moderate Low	Low	3.5-5.5	Moderate	High	4
Lehew	3 to 80	20 to 40''	Well	High	Low	3.5-5.5	Low	High	2
Lily	8 to 55	20 to 40''	Well	Moderately High	Low	4.5-5.5	Moderate	High	2
Litz	3 to 70	20 to 40''	Well	Moderately High	Low	4.5-6.0	Moderate	High	2
Lobdell	0 to 3	>5'	Moderately Well	Moderately High	Low	5.6-7.3	Low	Moderate	5
Lodi	8 to 35	>5'	Well	Moderately High	Moderate	4.5-5.5	Moderate	High	5

Lostcove	3 to 55	>5'	Well	Moderately High	Low	3.5-5.5	Low	High	5
Marbleyard	15 to 80	20 to 40'	Well	High	Low	3.5-5.5	Moderate	High	2
Maurertown	0 to 3	>5'	Poorly	Low	High	5.6-7.3	High	High	5
McCamy	3 to 15	20 to 40'	Well	Moderately High	Low	4.5-5.5	Moderate	High	2
McClung	8 to 55	>5'	Well	Moderately High	Low	4.5-5.5	High	High	5
Murrill	3 to 55	>5'	Well	Moderately High	Low to Moderate	4.5-6.0	Moderate	High	5
Myersville	3 to 15	40 to 60''	Well	Moderately High	Low	5.1-6.0	Moderate	Moderate	4
Needmore	0 to 70	20 to 40'	Well	Moderately High	Moderate	5.1-6.5	High	Moderate	3
Nicelytown	3 to 8	>5'	Moderately Well	Moderately High	Low	4.5-5.5	Moderate	High	5
Opequon	3 to 100	12 to 20''	Well	Moderately High	High	5.6-7.8	Moderate	Low	1
Oriskany	3 to 55	>5'	Well	High	Low	4.5-5.5	Moderate	High	5
Orrville	0 to 3	>5'	Somewhat poorly	Moderately High	Low	5.1-6.5	High	Moderate	4
Peaks	3 to 70	20-40''	Somewhat Excessively	High	Low	4.5-5.5	Moderate	High	2
Philo	0 to 3	>5'	Moderately Well	Moderately High	Low	4.5-6.0	Low	High	5

Pignut	3 to 70	20-40''	Well	Moderately High	Low	5.1-6.5	Moderate	Moderate	2
Plott	3 to 35	>5'	Well	High	Low	4.5-5.5	Low	High	4
Pope	0 to 3	>5'	Well	Moderately High	Low	3.5-6.0	Low	Low	4
Purdy	0 to 3	>5'	Poorly	Moderately Low	Moderate	3.5-5.5	High	High	5
Rough	15 to 100	4 to 10''	Somewhat Excessively	High	Low	3.5-5.0	High	High	1
Saunook	3 to 55	>5'	Well	Moderately High	Low	4.5-6.5	Moderate	High	5
Sensabaugh	0 to 3	>5'	Well	Moderately High	Low	5.6-7.8	Low	Moderate	4
Sherando	35 to 80	>5'	Well	High	Low	4.5-5.5	Moderate	High	3
Shottower	3 to 35	>5'	Well	Moderately High	Moderate	4.0-6.0	High	Moderate	4
Slabtown	0 to 15	>5'	Moderately Well	Moderately High	Moderate to High	5.6-7.8	Moderate	Low	5
Stumptown	15 to 80	20 to 40''	Well	High	Low	4.0-5.5	Moderate	High	2
Thunder	3 to 55	>5'	Well	Moderately High	Low	4.5-6.5	Moderate	High	5
Toms	0 to 3	>5'	Somewhat Poorly	Moderately Low	Moderate	5.6-7.8	High	High	5
Tumbling	3 to 35	>5'	Well	Moderately High	Low	4.5-5.5	Moderate	High	5

Tygart	0 to 3	>5'	Somewhat Poorly	Moderately Low	Moderate	4.5-5.5	High	High	5
Unaka	3 to 35	20-40"	Well	High	Low	4.5-5.5	Low	Moderate	2
Vanella	3 to 35	>5'	Well	Moderately High	Low	4.5-5.5	Moderate	Moderate	4/5
Watahala	8 to 55	>5'	Well	Moderately High	Low to Moderate	4.0-5.5	High	High	4
Weaver	0 to 3	>5'	Moderately Well	Moderately High	Low	7.0-8.4	High	Low	5
Weikert	3 to 100	10 to 20"	Well	High	Low	4.0-5.5	Moderate	Moderate	1
Wintergreen	8 to 35	>5'	Well	Moderately High	Moderate	3.6-5.5	High	Moderate	5
Wolfgap	0 to 3	>5'	Well	Moderately High	Low	6.1-7.8	Low	Moderate	5

Source: U.S. Department of Agriculture, Soil Conservation Service, 1931

The soils in Rockbridge County formed in residual, colluvial and alluvial parent materials. They are also referred to as residuum, colluviums and alluvium, respectively.

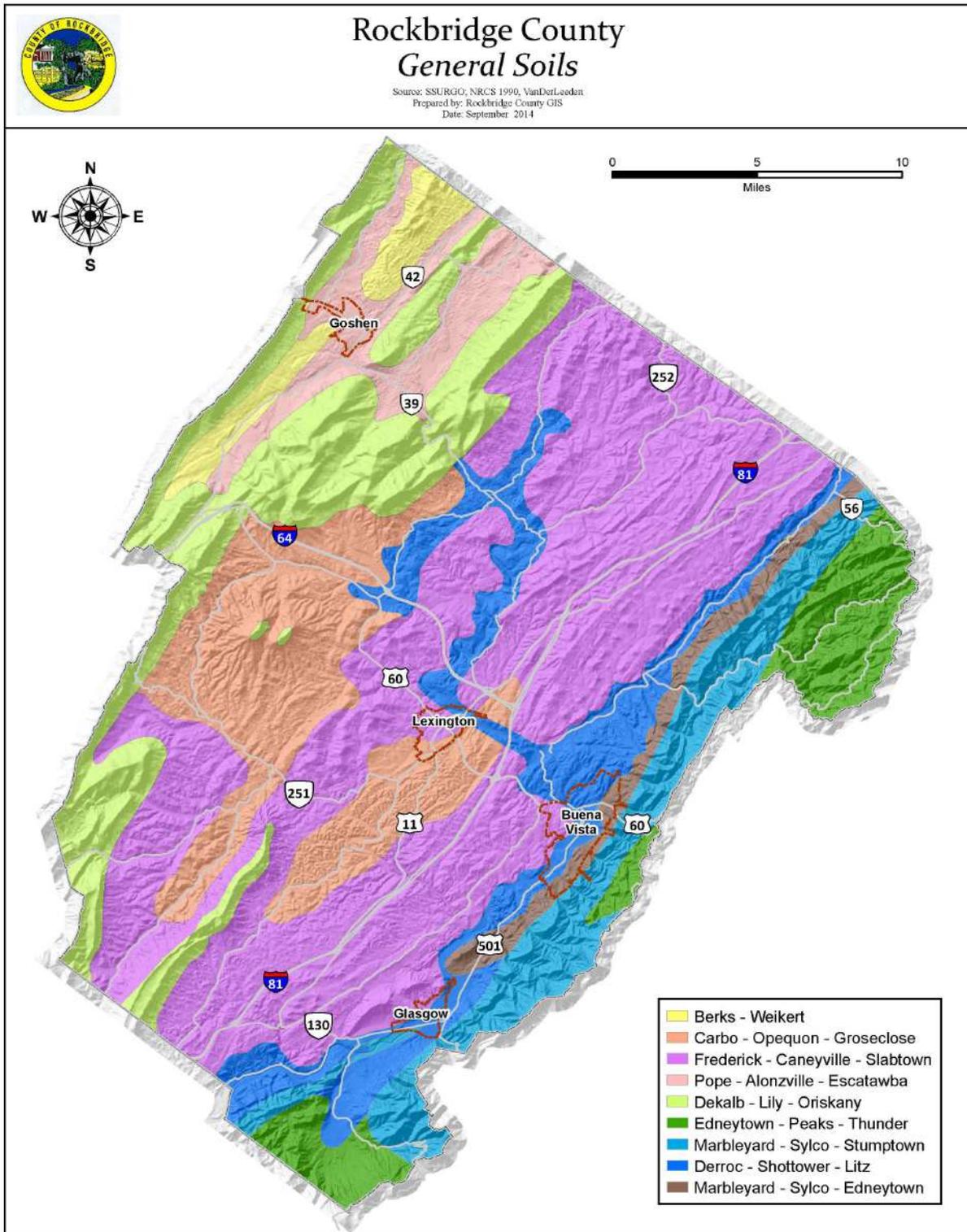
Residual parent materials are formed in place and include weathered sedimentary rocks such as limestone, dolomitic limestone, shale, siltstone, sandstone or quartzite and metasedimentary, igneous and metamorphic rocks. In general, residual parent materials are the oldest parent materials in the County. For example, Frederick soils have formed in residual limestone parent material and show a high degree of development. They are the dominant agricultural soils in the Valley. Dekalb soils have formed in residual sandstone parent materials but are not as well developed because the soil-forming processes have been hindered by highly resistant sandstone rock and steeper slopes.

Colluvium is made up of parent materials that have moved downslope from the residual soil positions. Typically, it is deposited on lower back slopes, foot slopes, toe slopes and at the head of and along drainageways. In general, it is younger than the residuum but nonetheless, the soil-forming processes have had time to influence the resulting soils. For example, the Oriskany soils have an accumulation of clay in the subsoil. Other colluvial soils, such as the Escatawba soils, which geomorphically are on foot slope positions, have formed in parent material which is actually very old. These soils are very strongly leached and have a clay pan.

Alluvium is made up of parent materials that have been or are actively being deposited by water on terraces and flood plains. Based on the stability of their landform positions, terrace soils range from relatively old to young. The soils on the mid to high level stream terraces, for example, Shottower soils, have well-developed profiles. The soils on the low stream terrace, for example, Alonzville soils, have moderately developed profiles. The youngest soils are found on the active flood plains. These soils have formed near present day rivers such as the Maury, Calfpasture, Little Calfpasture and South Rivers and streams such as the Buffalo, Kerrs, Walkers and Hays Creeks. Derroc soils, for example, have weakly developed profiles.

It should be noted that the general soil association map described above is not suitable for site planning or farm management because the soils in any one association may vary in slope, stoniness, drainage and other characteristics which affect use and management. In addition, within a particular association, there may be minor inclusions of other soil types having completely different characteristics. However, the general soil map is useful in county-wide planning because it provides broad scale information which can be used to determine general areas suitable for development, agriculture and other uses.

Map 2.5



AGRICULTURAL SUITABILITY

A recognized method known as LESA (Land Evaluation and Site Assessment) has been developed by the USDA to determine the quality of land for agricultural uses and to assess sites or land areas for their agricultural economic viability. Based on the general soil associations, three categories of agricultural suitability have been identified in Rockbridge County. These areas are shown in Map 2.6 and are described as follows:

Agricultural Area #1 – Prime Farmland

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber and oilseed crops, and is also available for these uses. The land could be cropland, pastureland, forest land or other land, but not built-up land or water bodies. Good soil quality, a long growing season and an adequate moisture supply are needed to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied.

In general, prime farmland in the county has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content and none too few rock fragments or rock outcrops. The water supply is dependable and of adequate quality. Prime farmland is permeable to water and air. It is not excessively erodible or saturated with water for long periods and it either is not frequently flooded during the growing season or is protected from flooding.

More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

Approximately 26,620 acres in the Rockbridge County survey area, or nearly seven percent of the total acreage, meet the requirement for prime farmland. This land is on flood plains, stream terraces and gently sloping uplands. Historically, it has been used primarily for agricultural purposes, mainly cropland, hayland and pastureland.

A recent trend in land use in some areas has been the loss of some prime farmland to industrial and urban uses. This loss puts pressure on marginal lands, which generally are more erodible, droughty and less productive and cannot be easily cultivated.

For some soils identified as prime farmland, measures are needed to overcome a hazard or limitation, such as flooding, wetness and droughtiness. On-site evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures.

Agricultural Area #2 – Statewide Important Farmland

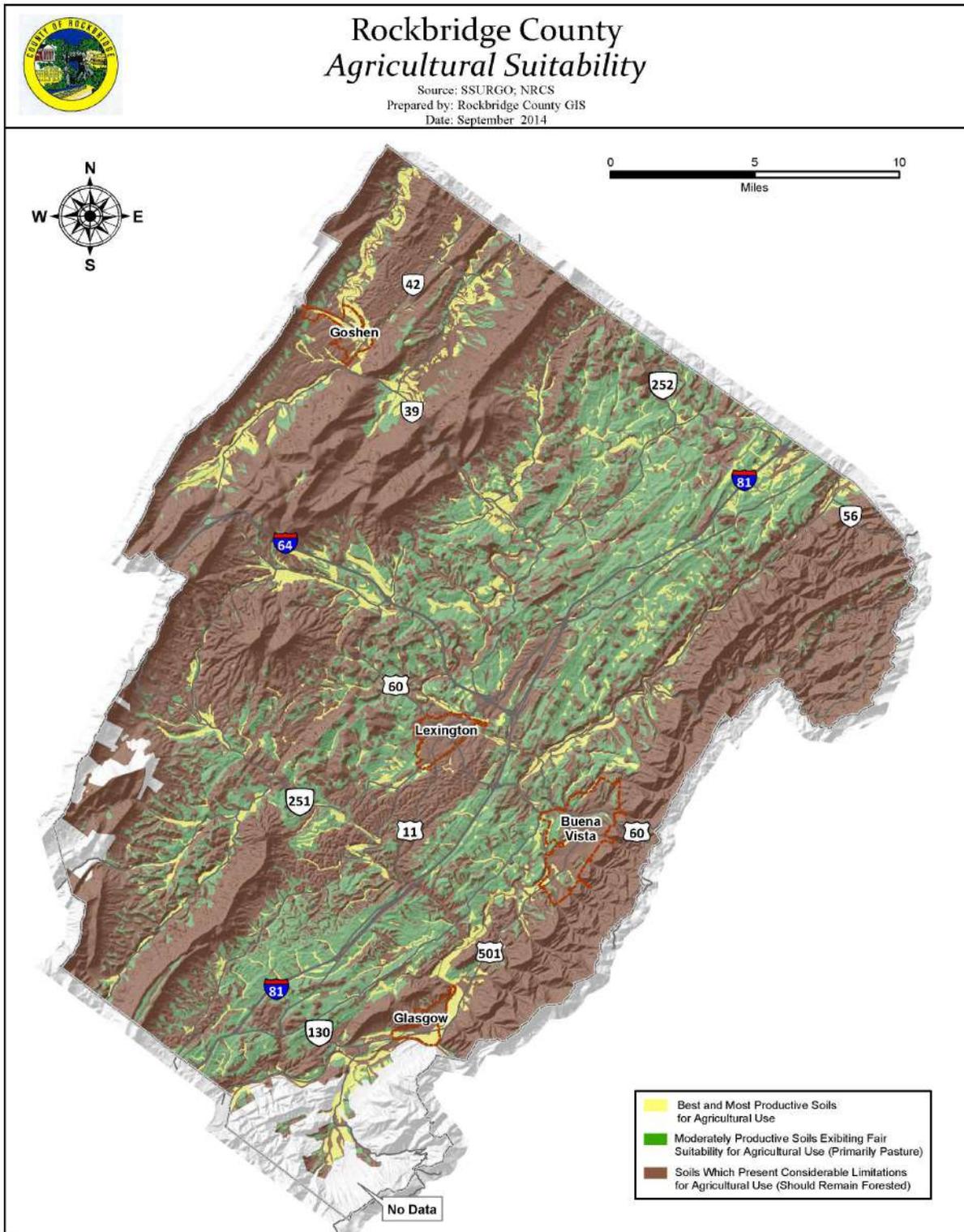
Land of statewide importance makes up 78,196 acres in the Rockbridge County survey area, and is land, in addition to prime farmland, that is of statewide importance for the production of food, feed, fiber, forage and oilseed crops. Generally, additional farmlands of statewide importance include those that are nearly prime farmland and that economically produce high yields of crops

when treated and managed according to acceptable farming methods. Some may produce as high a yield as prime farmland if conditions are favorable.

Agricultural Area #3 – Other Land

Unrated land covers the remainder of the County. It consists of land which may not be prime farmland or farmland of statewide importance, but may include farmland of local importance. Land which is owned by government organizations, such as the United States Forest Service, is also included in this category.

Map 2.6



SEPTIC TANK SUITABILITY

Of particular interest to Rockbridge County land users is the information concerning septic tank suitability. Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Suitability ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system and public health.

Permeability, depth to a water table, ponding, depth to bedrock or a cemented pan and flooding affect absorption of the effluent. Stones and boulders, ice and bedrock or a cemented pan interfere with installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in down slope areas. Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than four feet below the distribution lines. In these soils the absorption field may not adequately filter the effluent, particularly when the system is new. As a result, the groundwater may become contaminated.

Some soils in Rockbridge County present severe limitations to the functioning of septic tank absorption fields because they possess one or more of the above conditions. The soils primarily affected are the steep mountain soils, the flood plain soils and the moderately deep to shallow soils in the valleys. A rating of “very limited” in the soil survey indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design or expensive installation procedures. Poor performance and high maintenance can be expected.

The remaining areas present slight to moderate limitations although there may be inclusions of severely limiting soils. In all cases, an on-site investigation of the soils needs to be conducted and permitting needs to be obtained from the County Health Department.

WATER RESOURCES

Groundwater

Groundwater is an extremely important natural County resource. An estimated 18,000 County residents representing 7,400 households obtain their water from wells and springs. The City of Buena Vista and the Town of Glasgow depend on well water for public supply and the Town of Goshen obtains its water from a nearby spring. The large industrial facility of Mohawk in Glasgow uses well water for its industrial needs. The total groundwater withdrawal in the County is estimated to be between 5 and 10 mgd (million gallons per day).

A first assessment of groundwater availability in Rockbridge County was completed in 2004 (van der Leeden) and described the occurrence, quantity and quality as well as the movement of water in the subsurface. The report also contained a water budget for the County with estimated quantitative values for the components of the hydrologic cycle. Based on the county’s normal precipitation of 38 inches per year and stream base-flow calculations, groundwater recharge was

calculated to be 245 mgd. In addition to this renewable portion of water availability, vast amounts of groundwater are permanently stored in the subsurface.

An examination of 850 domestic, public supply and industrial water well records shows that most wells found sufficient water at depths of less than 300 feet; however, at some localities and in some aquifers, deeper wells may be required. In bedrock aquifers most of the fractures and solution openings are concentrated in the upper couple of hundred feet where most of the groundwater is encountered.

The groundwater flow system underneath the valley floor in the limestone and dolomite rock units is thought to be shallow and under water table conditions. (See Map 2.7) Groundwater flow velocities vary widely depending on local hydrogeologic conditions. Normal values vary inches per day to hundreds of feet per day, the latter typical in karst aquifers. As pointed out previously, as part of the hydrologic cycle, groundwater moves toward surface water bodies and discharges into streams, lakes or ponds. The groundwater component of surface waters varies seasonally. In September and October when rainfall is lowest, groundwater makes up most of the river flows. From these low-flow measurements an estimate of regional groundwater recharge can be made.

The water table or upper surface of the saturated zone lies at a variable depth below the land surface and fluctuates seasonally in accordance with recharge from precipitation, water loss from evapotranspiration and local groundwater withdrawals. Flowing wells in some county areas are indicative of confined or semi-confined conditions.

Some 20 different aquifers have been identified ranging from shales and sandstones to limestones, dolomites and crystalline rocks, varying in thickness from a few tenths a foot to thousands of feet. Typical domestic well yields vary from a few gallons per minute (gpm) to 10 gpm. Wells drilled in shale tend to have a higher yield than those tapping sandstone and crystalline aquifers. Wells drilled in carbonate aquifers display a variable yield ranging from extremely low (less than one gpm) to a high capacity (over 100 gpm).

The Waynesboro aquifer located at the foot of the Blue Ridge Mountains is the most important aquifer in the county and is capable of yielding large supplies of groundwater (1 mgd and over) to municipal and industrial wells. One municipal well in Buena Vista tapping this formation was tested at the rate of 1,100 gpm. The wells pumping rate was later reduced because of turbidity problems. Two industrial wells at Mohawk in Glasgow completed in the Waynesboro aquifer yield respectively 900 and 400 gpm.

Springs in the county are numerous and are used as water sources by many farms and older homes. Springs are places at the land surface where groundwater discharges naturally, or because of more complicated geologic conditions, where deeper groundwater is under pressure and discharges from solution channels in limestone bedrock. Most springs in the county are thought to reflect karst topography and are recharged by water entering sinkholes at the land surface. Table 2.5 lists the major springs in the County and Map 2.7 shows the distribution of major

springs. The flow of a spring can be constant throughout the year or fluctuate seasonally. At least four springs are reported to flow in excess of 2,000 gpm. A detailed survey of 29 major springs in the County was initiated by a Washington and Lee University geologist in 2004. Included in this survey were locations, aquifer identification, flow measurements and water analysis (Knapp, 2005).

Table 2.5 Major Springs in Rockbridge County

Name	Location	Date Measured	Discharge (gpm)	Aquifer
Big Spring	Near Kerrs Creek	2/17/1928	4,500	Beekmantown, Conococheague, Elbrook Fms.
		8/27/1962	2,220	
Black Spring	1.2 mi. northeast of Rapps Mill	2/16/1928	5,000	Beekmantown Fm
C.B. Leech Spring	4.4 mi. west of Murat	2/16/1928	630	Idem
Coleman's Spring	1.2 mi. northwest of Collierstown	2/17/1928	1,200	Middle Ordovician Undivided
Collierstown Spring 1	At Collierstown	2/17/1928	1,460	Idem
Collierstown Spring 2	2.4 mi. northwest of Collierstown	2/17/1928	300	Edinburg Fm
Fairfield Spring 95	1.5 mi. northeast of Fairfield	8/27/1962	225	Conococheague Fm
Gibbs Falls Spring	Near Wades Mill	8/27/1962	650	Elbrook Fm
Henderson Spring	0.8 mi. southwest of Rapps Mills	2/16/1928	1,000	Beekmantown, Conococheague, Elbrook Fms
Holmes Spring	Near Bells Valley	8/27/1962	360	Millboro Shale
Ira Dickson Spring	At Murat	2/17/1928	1,290	Beekmantown, Conococheague, Elbrook Fms
J.H. Ayers Spring	4 mi. southwest of Murat	2/16/1928	3,500	Idem
Magnesia Spring	At Rockbridge Baths	2/25/1928	600	Conococheague Fm

Marl Creek Spring	0.4 mi. west of Steeles Tavern	8/27/1962	360	Beekmantown Fm
McCorkle Spring	1.4 mi. west of Murat	2/17/1928	1,400	Idem
McNutt Spring	1.0 mi. north of Brownsburg	8/27/1962	225	Elbrook & Beekmantown Fms
Moore's Creek Spring	At Raphine	8/27/1962	1,000	Beekmantown Fm
Myers Spring	0.7 mi. north of Denmark	8/27/1962	200	Martinsburg Fm
Old Distillery Spring	3.2 mi. southeast of Goshen	3/23/1928	500	Oriskany Sandstone
		8/27/1962	225	
Reagon Spring	0.8 mi. southwest of Rapps Mill	2/16/1928	1,200	Beekmantown Fm
School House Spring	0.7 mi. north of Natural Bridge	2/15/1928	250	Stonehenge Fm
Seahorn Spring	2 mi. northwest of Collierstown	2/17/1928	2,500	Middle Ordovician Undivided
		8/14/1985	350	
Unnamed	West of Bustleburg	8/27/1962	450	Elbrook Fm
Warm Spring	1.8 mi. northwest of Goshen	3/21/1929	800	Oriskany Sandstone
		8/27/1962	1,000	

Source: Van der Leeden, 2004 and Knapp, 2005

Ground water levels are measured by the U.S. Geological Survey in an observation well located in Glasgow. This well is 695 feet deep and monitors the water level in the Shady Dolomite aquifer. A second, privately owned well located in the Poplar Hill area monitors water levels in the Martinsburg Formation and is 480 feet deep.

The quality of groundwater in the County appears to be excellent, although the number of analyses is limited. Water from carbonate rocks is typically hard to very hard, water from crystalline rocks, shales and sandstones is softer and contains lower amounts of dissolved solids. Bacterial contamination in domestic wells could be problematic and needs further investigation. Groundwater quality is discussed in more detail in the Water Quality section.

Surface Water

The entire area of Rockbridge County lies within the James River Drainage Basin. The James River courses ten miles through the southeastern corner of the County, directly draining only 9 percent of the County's area. The remaining 91 percent of the County is drained by the Maury River and its tributaries. The Maury River flows approximately 50 miles through the County and joins the James River just above Balcony Falls at the James River Gap.

Streamflow in Rockbridge County is measured at four gauging stations operated by the U.S. Geologic Survey. These gauges are located on the Calfpasture River, the Maury River (2) and Kerrs Creek (see Map 2.7 and Table 2.6). A fifth station, installed and operated by Washington and Lee University, began operation in September, 2011. This gage monitors flow in Woods Creek. Table 2.6 lists the stations, period of record and mean and maximum flow expressed in cubic feet per second (cfs). Non-active stations with partial streamflow data and their period of record are also listed.

Table 2.6 Streamflow Gaging Stations

ACTIVE

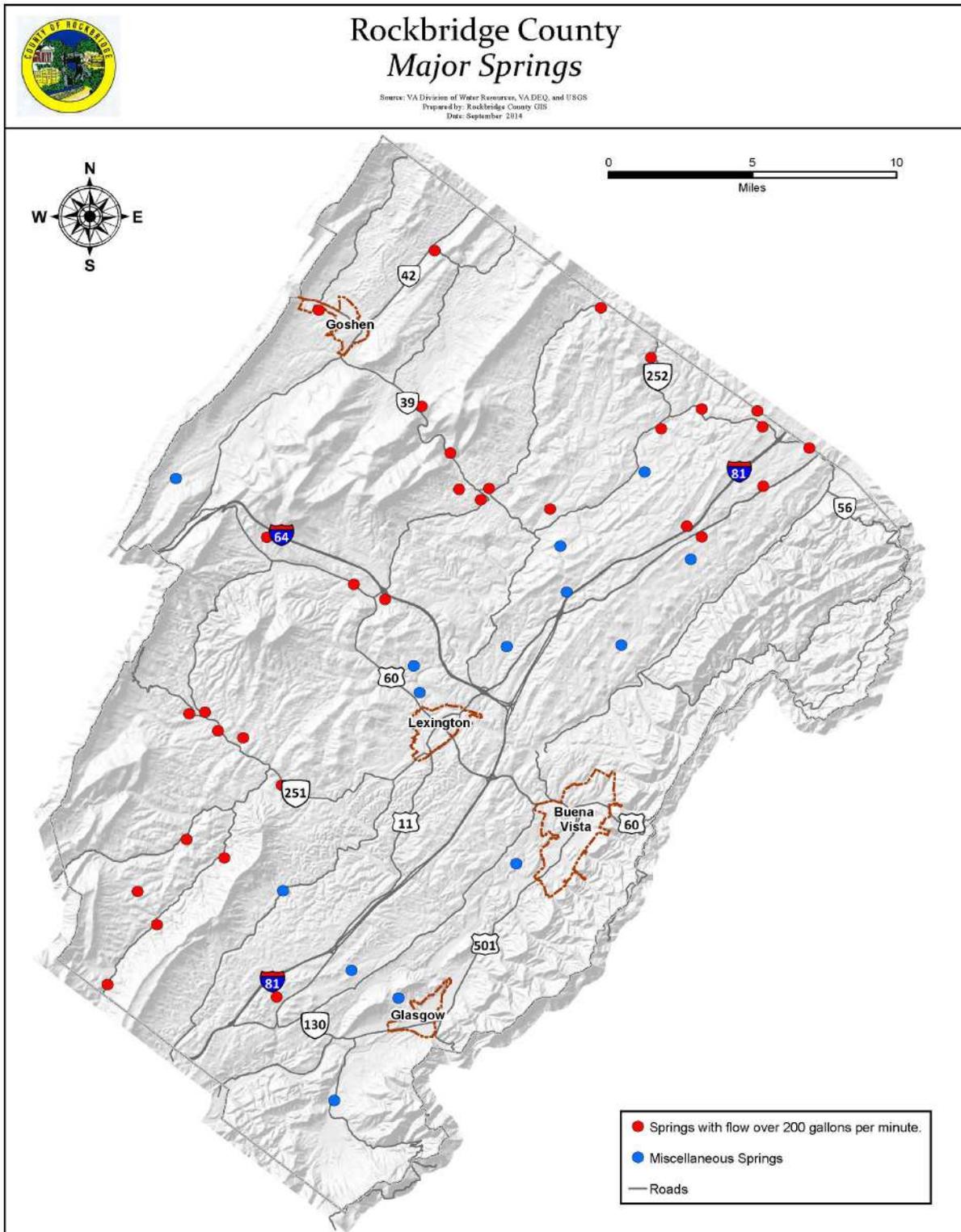
Station No.	Stream & Gaging Station	Drainage Area Sq. Mi.	Period Of Record	Mean Flow Cfs	Maximum Flow Cfs	Date
2020500	Calfpasture River above Mill Creek	141	1938-96 & 1998-present	168	56,300	Nov. 4, 1985
2021500	Maury River at Rockbridge Baths	329	1928-present	384	87,700	Nov. 5, 1985
2022500	Kerrs Creek near Lexington	35.1	1926-present	36.2	23,000	Sept. 10, 1950
2024000	Maury River near Buena Vista	647	1938-present	677	105,000	Aug. 20, 1969
	Woods Creek at W&L Campus	Estimated 6	Installed September, 2011			

NON-ACTIVE

Station No.	Stream And Gaging Station	Period Of Record
2020170	Elk Creek in Arnolds Valley	1982-1985
2021700	Cedar Grove Branch near Rockbridge Baths	1967-1995
2023000	Maury River near Lexington	1926-1960
2023500	South River near Riverside	1949-1962
2024240	South Buffalo Creek near Lexington	1982-1985
2024300	Buffalo Creek near Glasgow	1962-1964
2024500	Maury River near Glasgow	1895-1905
2024900	Pedlar Creek near Buena Vista	1941-1984

Source: U.S. Geological Survey Water Data, 2012; waterdata.usgs.gov/va/nwis

Map 2.7



An unusual characteristic of the surface drainage in Rockbridge County is the occurrence of large “closed drainage areas.” These closed drainage areas are related to the caves, sinkholes, and subsurface drainage patterns which are common in a limestone region such as the Shenandoah Valley. A closed drainage area is the entire area which drains directly into a sinkhole; the water enters the groundwater supply rather than draining directly into a stream. Closed drainage areas account for 9,843 acres, or 2.5 percent of the total County area.

Based on the major streams in Rockbridge, the County can be divided into eight major drainage areas (see Map 2.7) discussed below. Stream flow is given in cubic feet per second (cfs) and million gallons per day (mgd).

James River Drainage Basin

The James River Drainage basin is located in the southeast corner of the County and covers 36,044 acres. Included in this area is the James River and those minor tributaries that drain directly into it. Elk Creek, draining the Arnold’s Valley area and Cedar Creek, flowing off of Short Hills Mountain, are the only significant tributaries. There is no gaging station on the James River in Rockbridge County, but in adjacent Botetourt County at Buchanan, 12 miles south of the County border, the James has a median flow of 2,508 cfs or 1.6 billion gallons per day (bgd). The peak flow on record occurred on November 5, 1985, and was 179,000 cfs. The minimum flow on record occurred on October 1, 1981, and was 257 cfs or 166 mgd.

Maury River Drainage Basin

The Maury River drainage basin winds through the central portion of the County and occupies 103,450 acres. Included in this drainage area are the Maury River and the smaller streams flowing directly into it. The major tributaries to the Maury River are considered below as separate drainage areas.

In its upper reaches near Rockbridge Baths, the Maury has an average flow of 384 cfs or 248 mgd. In its lower reaches near Buena Vista, it has an average flow of 677 cfs or 438 mgd. The maximum flow on record at Buena Vista occurred in August, 1969, and was approximately 105,000 cfs. The minimum flow on record at Buena Vista occurred on October 10, 1941, and totaled only 22 cfs or 14 mgd. The minimum flow on the Maury at Rockbridge Baths occurred on September 10, 1966, and measured only 7.1 cfs or 4.6 mgd.

Buffalo Creek Drainage Basin

In the southwest portion of the County is the Buffalo Creek Drainage basin which covers 78,252 acres. In this area four tributaries – South Buffalo, North Buffalo, Blacks Creek and Colliers Creek – join near Collierstown forming Buffalo Creek, which flows in an easterly direction to its confluence with the Maury River. From a limited period of measurements, the low flow from this drainage basin was estimated to be between 23 to 26 cfs or 15 to 17 mgd, with a mean high flow of 121 cfs or 78 mgd.

South River Drainage Basin

The northeastern section of the County is in the South River Drainage basin, which covers 59,201 acres. There are an additional 17,055 acres of the South River Basin in adjoining Augusta

County. The South River flows southward and joins the Maury River midway between Lexington and Buena Vista. From available measurements made in the 1949-1962 period, low flow discharge from this basin was estimated to be between 40 and 46 cfs or 26 to 30 mgd. High flow rates reached 47 cfs or 31 mgd.

Kerrs Creek Drainage Basin

The Kerrs Creek Drainage basin is located in the west central portion of the County and occupies 29,931 acres. Kerrs Creek flows in an easterly direction and joins the Maury River just north of Lexington. The mean discharge from the Kerrs Creek basin is 36.2 cfs or 23 mgd. The peak flow of 23,000 cfs or 15 bgd occurred in September, 1950 during a flash flood caused by more than 5 inches of rain. The minimum flow on record of 2.2 cfs or 1.4 mgd occurred in October, 2008.

Hays Creek Drainage Basin

The Hays Creek Drainage basin covers 30,166 acres in the north central part of Rockbridge County. There are an additional 20,459 acres of the Hays Creek Drainage basin in Augusta County. Hays Creek flows southward and joins the Maury River at Rockbridge Baths. No official flow measurements have been made in this watershed, but low flow estimates range from 9 to 16 cfs or 6 to 10 mgd.

Little Calfpasture River Drainage Basin

The Little Calfpasture River Drainage basin is located in the northwestern part of the County. The Little Calfpasture flows southward, draining approximately 16,583 acres of the County. There are an additional 36,146 acres of the watershed in adjoining Augusta County. Official records are not maintained on this river, but it is estimated that the minimum flow from the Little Calfpasture Drainage basin ranges between 1.6 and 2.9 cfs or 1 to 2 mgd.

Calfpasture River Drainage Basin

The Calfpasture River Drainage basin is located along the northwestern edge of Rockbridge County and covers 40,853 acres. In addition, there are 27,485 acres of the Calfpasture Drainage Basin in Bath County and 81,238 acres in Augusta County. The Calfpasture River joins the Little Calfpasture River at Goshen Pass, forming the Maury River. The major tributaries to the Calfpasture in Rockbridge are Mill Creek and Brattons Run. The mean discharge from the Calfpasture Drainage area is 168 cfs or 109 mgd. The maximum discharge on record was 56,300 cfs and occurred in November, 1985.

FLOODS

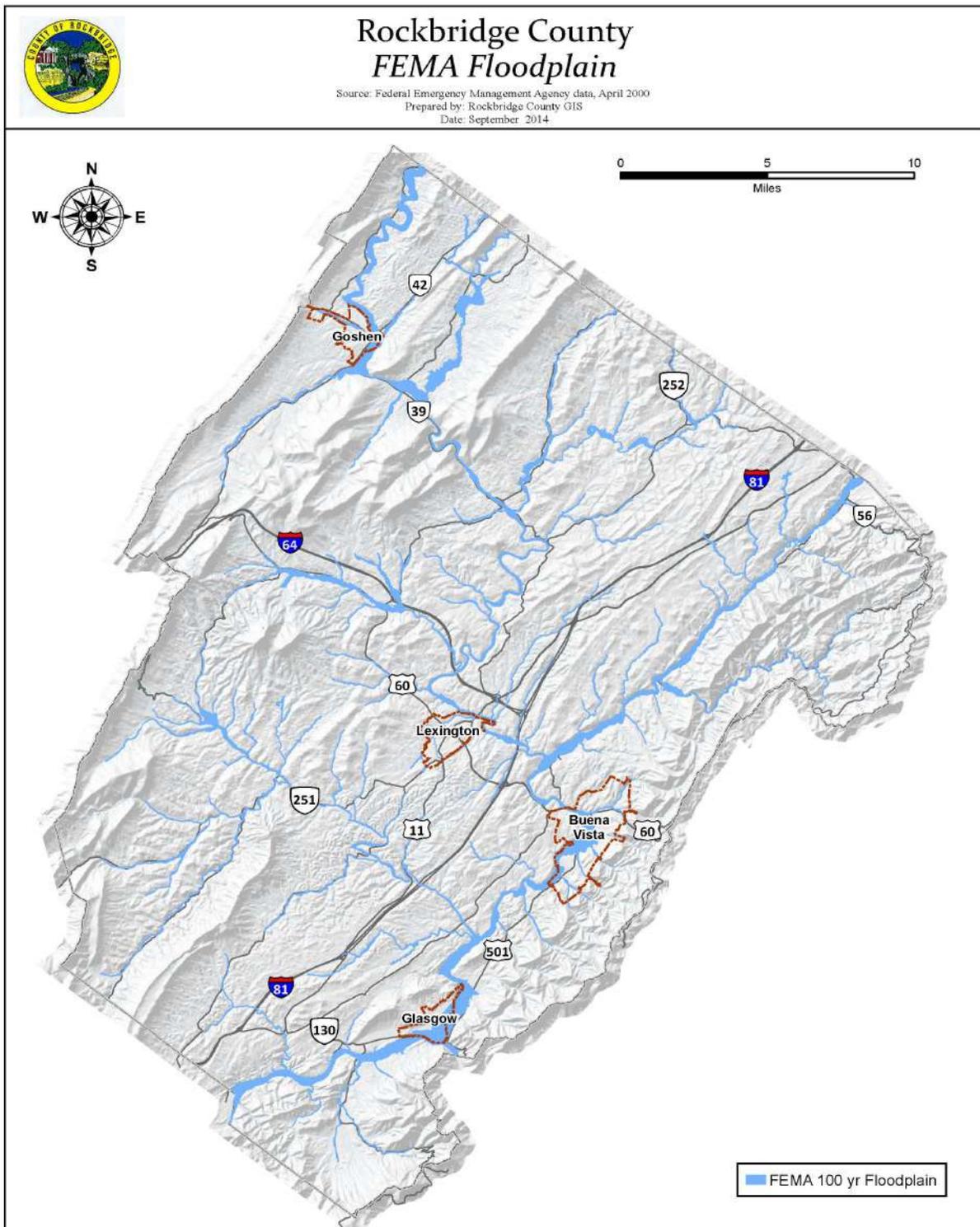
Floods have been recorded throughout the history of Rockbridge County. Since 1771, when the first flood was documented, 11 major floods have occurred with loss of life and great damage to the local economy. The County is frequently plagued by flash floods caused by a combination of heavy precipitation and steep topography. Occasionally, slow-moving storms and the remnants of hurricanes cause extensive flooding. In 1992, the Rockbridge Area Conservation Council published "*Floods in Rockbridge County – History and Vulnerability of Flooding*," the first county-wide study of flooding.

Floods can occur anytime during the year, perhaps more likely in spring and summer months as indicated by the record. Losses of both human life and property have been significant. Torrential rains from Hurricane Camille in August, 1969, caused heavy damage in the eastern half of the County with 23 dead and \$30 million in property damage. Damage from the November, 1985 flood totaled over \$100 million and that of the more recent April, 1992 flood event was estimated at \$5 million.

Most of the rivers and valley streams in the County, including those along the industrial and urban areas of Buena Vista and Glasgow, are subject to flooding during times of heavy rains or quick thaws. The Federal Emergency Management Agency (FEMA) has published Flood Insurance Rate Maps in conjunction with the Flood Insurance Program of the Federal Insurance Administration. These maps show the approximate areas of land that are subject to inundation from a 100-year flood on a scale of 1 inch = 2,000 feet. The urban areas subject to flooding are shown on more detailed maps. Map 2.8 illustrates the floodplains identified by FEMA.

A flood protection system for the City of Buena Vista was completed in 1997 by the U.S. Corps of Engineers and is designed to protect the City from a 100-year flood; it consists of a levee and flood wall and a channel to control interior drainage. The Maury River was also dredged and widened as it passed through the City. Land use and management practices should include measures to avoid flood damages. Included should be land stabilization measures to avoid soil erosion and reduce damaging sedimentation downstream. This can be accomplished by natural vegetation as well as by man-made improvements such as dikes, gullies and floodwater diversions. The floodway should generally be left undeveloped to prevent both property damage and environmental damage. Increased water pollution during flood events can be expected in developed areas. A natural floodway provides a valuable function for society and it does so at no cost. Efforts to fill and develop a floodway are generally quite costly in the long run. The resultant restrictions in the floodway force the water to other areas, or cause a faster flow and more severe damage downstream.

Map 2.8



SURFACE WATER QUALITY

Surface water quality in Virginia is monitored by the Department of Environmental Quality (DEQ) in order to determine how well the waters meet the goals of the Federal Clean Water Act (CWA) for fishable and swimmable waters. Sources of drinking water must meet Federal and State water quality standards. Section 303(d) of the CWA requires each state to submit a Total Maximum Daily Load (TMDL) priority list to EPA in even-numbered years. This TMDL rating for impaired waters is based on the severity of the impairments, including beneficial uses lost, the number and type of pollutants and the presence of endangered species.

The primary water quality standards used to assess surface water quality are fecal coliform bacteria, dissolved oxygen, pH and temperature. Virginia's surface water quality standards for pH, temperature and dissolved oxygen applicable to Rockbridge County streams are presented in Table 2.7. Fecal coliform bacteria counts can indicate the presence of improperly treated sewage and are used to determine if the waters are safe for swimming. Any sample containing more than 1,000 fecal coliform bacteria cells per 100 milliliters of water at any time violates the instantaneous standard. To be considered fully supporting of the swimmable goal, the instantaneous fecal coliform bacteria standard must be met in at least 90 percent of the samples collected. A water body partially supports the swimmable goal if the violation rate is 11 to 25 percent. Waters with a higher violation rate are classified as not supporting the swimmable goal.

Dissolved oxygen (DO) is necessary for the survival of fish and other aquatic organisms. When oxygen levels are depressed due to the introduction of oxygen-consuming wastes, many naturally occurring species decline in numbers or disappear from the affected area. Cold water fish such as trout require higher oxygen levels than warm-water fish (e.g., bass). To be considered fully supporting of the fishable goal, the instantaneous standard for dissolved oxygen must be met in at least 90 percent of the samples collected.

Table 2.7 Numerical Criteria for Dissolved Oxygen, pH and Temperature in Surface Water

Description of Waters	Dissolved Oxygen mg/L		pH	Max. Temperature °C /°F
	Min.	Daily Avg.		
Mountainous Zones Waters	4.0	5.0	6.0-9.0	31/88
Stockable Trout Waters	5.0	6.0	6.0-9.0	21/70
Natural Trout Waters	6.0	7.0	6.0-9.0	20/68

Source: Virginia Water Quality Standards, 2011

Acidity or alkalinity of water is measured as pH. The pH scale ranges from zero (highly acidic) to 14 (highly basic). A pH of seven is neutral. Aquatic life can survive over only a limited range of the pH scale around the neutral value of seven.

Temperature standards are also set to protect aquatic life. Maximum allowable temperatures are lower in trout streams and higher in streams that support warm water fishes like bass. The State

also analyzes for the presence of toxic substances in water, fish tissue and sediment and biological assays are carried out in known problem areas.

Although the quality of streams in the County is basically good, the bacterial quality is of concern. According to the DEQ's .303 (d) Impaired Waters List of 2014, the water in most streams in the County is impaired because of the presence of fecal and E.coli bacteria, indicative of waste from human or animal origin (Table 2.8). The presence of these bacteria in the County's streams is not surprising and is thought to be primarily due to cattle feces in the runoff. Malfunctioning septic systems can also contribute to this problem as contaminated groundwater discharges into the streams. Overflows from sewage treatment plants are rare but can be a significant, temporary, water contaminant.

Table 2.8 Impaired Streams in Rockbridge County, 2014

Impaired Use	Name of Stream/Location	Reason for Listing	Stream Miles Affected
Fish Consumption	James River from Balcony Downs to Holcomb Creek	Mercury in Fish Tissue	7.42
Recreation	James River from Balcony Downs to Holcomb Creek	E-Coli	7.42
Recreation	Cedar Creek to James River Confluence	E-Coli and Fecal Coliform	12.1
Recreation	Elk Creek to James River Confluence	E-Coli	3.98
Recreation	Calfpasture River at Tizzle Branch to Hamilton Branch Confluence	E-Coli	2.83
Recreation	Mill Creek to Calfpasture River Confluence	E-Coli and Fecal Coliform	2.08
Aquatic Life	Piney Branch to Guys Run Confluence	pH	2.33
Aquatic Life	Little Calfpasture from Lake Merriweather Dam Downstream to Calfpasture River Confluence	Benthic-Macroinvertebrate Bioassessments	.84
Recreation	Cedar Grove Branch to Maury River Confluence	E-Coli and Fecal Coliform	4.62
Recreation	Maury River/Calfpasture River/Little Calfpasture River Confluence to Hays Creek Confluence	E-Coli	6.22
Recreation	Kerrs Creek to Maury River Confluence	E-Coli	11.86
Recreation	Moffatts Creek to Hays Creek Confluence to Maury River Confluence	E-Coli and Fecal Coliform	20.8
Recreation	Walkers Creek and Tributaries to Hays Creek Confluence	E-Coli	8.79

Recreation	Otts Creek Confluence to Moffatts Creek Confluence	E-Coli	5.5
Recreation	Mill Creek and Tributary to Maury River Confluence	E-Coli and Fecal Coliform	9.13
Recreation	Woods Creek and Tributary to Maury River Confluence	E-Coli	6.05
Aquatic Life	Woods Creek and Tributary to Maury River Confluence	Benthic-Macroinvertebrate Bioassessments	6.05
Aquatic Life	Moore's Creek and Tributaries to South River Confluence	Benthic-Macroinvertebrate Bioassessments	9.09
Aquatic Life	Irish Creek/Nettles Creek Confluence to South River Confluence	Temperature, water	8.53
Aquatic Life	Marl Creek and Tributaries to South River Confluence	Benthic-Macroinvertebrate Bioassessments	7.74
Recreation	South River/Moore's Creek Confluence to Irish Creek Confluence	E-Coli	7.95
Fish Consumption	Maury River/South River Confluence to James River Confluence	PCB in Fish Tissue	16.92
Recreation	Poague Run and Tributaries to Maury River Confluence	E-Coli	17.12
Aquatic Life	Lexington Reservoir	Oxygen, Dissolved and pH	22.60
Recreation	Buffalo Creek/Moore's Creek Confluence to Maury River Confluence	E-Coli and Fecal Coliform	16.09
Recreation	Colliers Creek to Buffalo Creek Confluence	E-Coli and Fecal Coliform	15.11
Aquatic Life	Colliers Creek to Buffalo Creek Confluence	Benthic-Macroinvertebrate Bioassessments	15.11
Recreation	South Fork Buffalo Creek to Buffalo Creek Confluence	E-Coli	14.47
Recreation	North Fork Buffalo Creek to Buffalo Creek Confluence	E-Coli	7.57

Source: DEQ, 2014 – Section 303 (d) List.

Other problems are elevated water temperatures in Irish Creek and PCBs found in fish tissue in the Maury River, from Buena Vista to its confluence with the James River. PCBs, originally used in electrical transformers, probably originated in industrial facilities in the Buena Vista area. These pollutants do not degrade by natural processes and are probable carcinogens. PCBs were found in Redbreast Sunfish, Rock Bass, Yellow Bullhead Catfish and Carp. A health advisory is in effect and no more than two meals per month should be consumed of these species.

In addition to the water sampling by the DEQ, the biological health of the County's streams is watched over by the Maury Watershed Monitors, a volunteer group affiliated with the Rockbridge Area Conservation Council (RACC) and Virginia Save Our Streams (VASOS) to determine benthic life (macro invertebrate) in each stream. VASOS currently has 12 monitoring stations where periodic samples are taken. Sampling results are entered in a state-wide data base.

Water Pollution

Water pollution in Rockbridge County can generally be grouped under four headings: sediment, agricultural pollution, domestic waste and industrial waste. Sediment is derived from plowed fields, overgrazed pastures, logging operations, highway construction and commercial development. The nature of the landscape in the county is such that during storm events, large quantities of topsoil are washed in to the water ways. Once in the stream, this sediment accumulates on the bottom where it can destroy the habitat of bottom-dwelling organisms. These sediments frequently contain chemicals derived from land application of fertilizers and pesticides. Fine sediments are of particular concern because they can harm fish by clogging and abrading their gills, by reducing their ability to capture food and by exposing them to disease organisms carried by the sediment. No information is available on rates of erosion and sedimentation in the county.

An occasional, but serious, source of sediment pollution in the county is Lake Merriweather operated by the Boy Scouts of America. This lake is drawn down periodically, flushing bottom sediments and inorganic material into the Little Calfpasture River and the Maury River.

Agricultural pollution is derived primarily from manure runoff, spraying of pesticides and application of fertilizers. Cow manure contains nitrogen and phosphorous, both of which are easily soluble and can end up in groundwater and surface water. Good pasture management, including watering troughs and construction of buffer zones along creeks, can greatly reduce agricultural pollution.

Rockbridge County also experiences pollution problems from point sources, such as thousands of septic tanks. The Town of Goshen does not have a sewer system and the entire population depends on septic tanks for waste disposal. Discharge from septic tanks located near streams or near sinkholes can easily cause water pollution.

Table 2.9 lists permitted wastewater discharges in the county and Map 2.9 shows location. Included are the three major wastewater treatment plants in Lexington, Buena Vista and Glasgow, and large industrial facilities in Buena Vista and Glasgow.

Pollution caused by some older facilities in the Goshen area, namely Stillwater Mills and Stella Jones (formerly Burke Parsons Bowlby), are no longer of concern as remedial action by the DEQ at both sites has prevented further discharges. The Stillwater plant stopped operation in 2004. Monitoring wells at this site showed some soil pollution, but there is no threat to surface water. At the Stella Jones plant, a geotextile membrane was installed to prevent creosote from moving

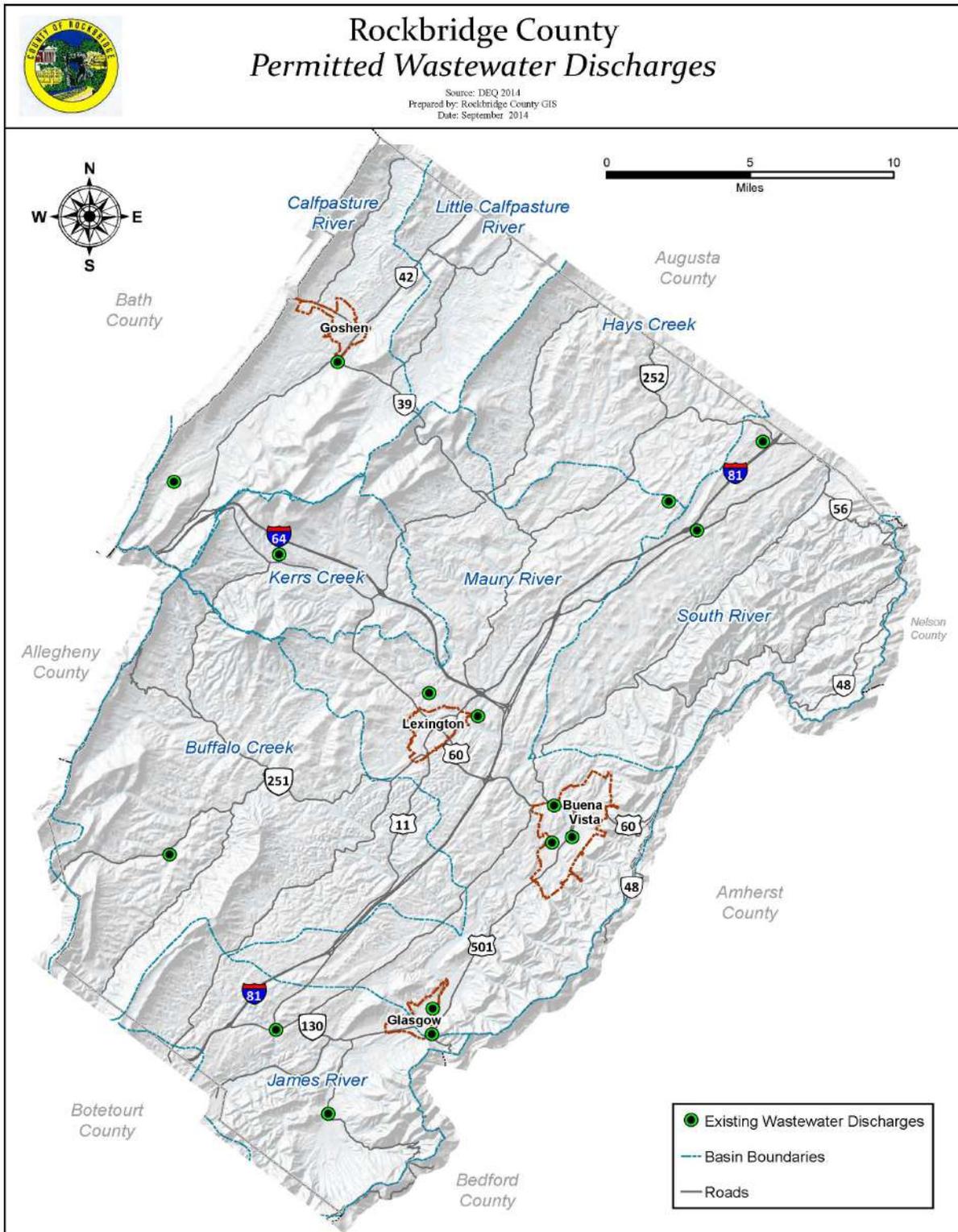
into the soil zone. Monitoring wells were installed to measure copper, arsenic and zinc levels. Both sites are in environmental compliance and no longer pose a threat to surface water.

Table 2.9 Permitted Wastewater Discharges

Facility name	Permit #	Description	Location	Design Flow, mgd	Total Flow, mgd
Fairfield Square	0089885	Minor/Municipal	4651 N. Lee Hwy, Fairfield	0.013	.000
Buffalo Spring Trout Farm	0091286	Minor/Industrial	2479 Bluegrass Trail, Lexington	2.8	
Mohawk Industries Inc.	0004677	Major/Industrial	404 Anderson St., Glasgow	0.5	0.792
Natural Bridge of Virginia	0024101	Minor/Municipal	15 Appledore Ln., Natural Bridge	0.099	
Rockbridge Alum Springs STP	0086967	Minor/Municipal	170 Spring House Rd., Goshen	0.04	0.04
Town of Glasgow WWTP	0083712	Minor/Municipal	Ninth St., Glasgow	0.495	0.495
Rockbridge Middle School	0021148	Minor/Municipal	1200 Sterrett Road, Fairfield	.0088	.000
Natural Bridge Juvenile Correctional Center	0027944	Minor/Municipal	1425 Arnolds Valley Rd., Natural Bridge Station	0.0175	
Stella-Jones	0080241	Minor/Industrial	9223 Maury River Rd., Goshen	0	0
Pilot#4649	0088277	Minor/Industrial	713 Oakland Circle, Raphine	0.015	0.015
Bontex Inc	004791	Minor/Industrial	1 Bontex Dr., Buena Vista	0.3	0.363
Buena Vista STP	0020991	Major/Municipal	301 W. 10 th St., Buena Vista	2.25	
Modine Manufacturing Co – Buena Vista	002771	Minor/Industrial	1221 Magnolia Ave., Buena Vista	0.136	0.136
Lexington-Rockbridge Regional WQCF	0088161	Major/Municipal	135 Bob Atkins Circle, Lexington	3	

SOURCE: DEQ, 2016 WWTP–Wastewater Treatment plant; STP–Sewage treatment plant; WQCF–Water quality control facility

Map 2.9



GROUND WATER QUALITY

Water is an excellent solvent, and groundwater in contact with rocks in the subsurface contains minerals in solution. The chemical composition of the various aquifers as well as contact time determine, to a great extent, the ultimate chemical composition of groundwater, springs and wells and the eventual use of the water. Analysis of water from springs and wells can provide insight into the sources of dissolved constituents and the pathway traveled by groundwater.

Groundwater is recharged by precipitation which can be polluted by atmospheric deposition of acidic substances. Fortunately, in Rockbridge County, areas underlain by limestone rocks and thick soils act as buffers, neutralizing most of these acids. However, areas underlain by hard, crystalline rocks (Blue Ridge Mountains) have little ability to neutralize the acidity and are most sensitive to atmospheric deposition of acidic substances. Under certain geologic and topographic conditions, groundwater can be recharged by surface water or overland runoff, both of which can be polluted.

Information on the quality of groundwater is limited as no organized county-wide sampling, analysis and interpretation has taken place. Available are geochemical data from 29 major springs surveyed by Washington & Lee University scientists (Knapp, 2005). Measurements made included pH, conductivity, temperature, alkalinity and major and trace composition. This survey also established the chemical correlation between spring water and source rock type. Also available are analyses of water from the County's public supply wells and from test wells installed during the Hadson power plant project in 1990. The files of DEQ contain some 300 chemical analyses of well and spring water collected from 1977 onward. Some of these water samples were collected at waste disposal and pollution sites, but they also include analyses of water from wells at schools, restaurants and manufacturing parks. Generalized water quality data on 143 County household well systems were obtained during a 1995 survey conducted by Virginia Tech.

Virginia's water quality standards for drinking water are based upon and consistent with the U.S. Environmental Protection Agency (EPA) water quality standards and apply to both surface and groundwater sources. For drinking water, standards are in place for inorganic and organic constituents, including volatile organics, pesticides, heavy metals and radionuclides as well as microbiological organisms. Limitations for the presence of contaminants in drinking water are referred to as Maximum Contaminant Levels (MCLs).

The water furnished by public water systems is monitored on a regular basis by the Virginia Department of Public Health. These systems include Buena Vista, Goshen (spring), Brownsburg, Raphine, Glasgow, Arnolds Valley and some 25 smaller systems that include manufactured home parks, schools, hotels, camps and developments. Analyses of water pumped from public supply wells show that the water is of excellent quality with no presence of volatile organic chemicals and radionuclides. Private wells are not monitored by the Health Department, except for a one-time mandatory analysis of bacteriological quality upon installation of the well and as required when the property is sold.

Some generalized comments can be made regarding groundwater quality in the County.

pH

The pH, a measure of acidity or alkalinity, of groundwater ranges from 5.4 to 8.4, with a value of 7.0 being neutral. Water from limestone and dolomite limestone and dolomite rocks had a median pH of 7.5. Lower pH values occur in groundwater from crystalline rocks.

Temperature

The groundwater temperature is roughly equivalent to the median annual temperature in the region which is 55.2 °F. Measured temperatures in well water range from 53°F to 56°F. Springs are somewhat higher, from 54°F to 72°F. Several springs in the County have temperatures of 66° F or even 72°F, indicating the presence of deep and warmer circulating groundwater.

Hardness

Groundwater in contact with rocks high in calcium or magnesium will dissolve minerals that can precipitate and form scale in pipes and water heaters. The median hardness of water from wells in carbonate rocks is 243 mg/L. Groundwater from wells tapping shale rock has a median hardness of 134 mg/L. The hardness of water from crystalline rocks is lowest and ranges from 3 to 89 mg/L.

Sodium

Sodium concentrations in spring and well water are low and range from 2 to 55 mg/L, well below the drinking water standard of 250 mg/L.

Sulfate and Hydrogen Sulfide

Concentrations of sulfate in groundwater are generally low and range from 1 to 22 mg/L, well below the drinking water standard of 250 mg/L. Water from one aquifer, the Martinsburg Shale, frequently yields water with objectionable hydrogen sulfide gas, requiring treatment.

Chloride

Chloride levels in groundwater range from less than 1 to 46 mg/L, with a median value of 2.6 mg/L, well below the 250 mg/L drinking water standard. High chloride levels could be an indication of man-made aquifer pollutions.

Total Dissolved Solids

Total dissolved solids (TDS) is the sum of all dissolved mineral constituents in water. TDS concentrations in groundwater range from 18 to 380 mg/L and are below the drinking water standard of 500 mg/L. The highest TDS levels occur in wells tapping limestone or dolomite rocks and the lowest levels occur in water from wells tapping crystalline rocks.

Nitrate

Nitrate concentrations in groundwater are very low and well below the recommended limit of 10 mg/l for drinking water. Nitrate concentrations in 19 public supply wells ranged from 0.01 to 4.62 mg/L, with a median value of 0.56 mg/L.

Iron and Manganese

Iron and manganese levels in groundwater are generally low, but some crystalline, limestone, shale or sandstone aquifers frequently carry water high in these constituents. Iron bacteria can be present and produce problems such as clogging and staining of appliances. The recommended limit for iron in drinking water is 0.3 mg/L and for manganese 0.05 mg/L.

Bacteriological Quality

Data on bacteriological quality of groundwater are limited to public supply wells and a 1995 Virginia Tech survey of 143 private water systems. Public water systems are sampled for coliform bacteria and, if needed, for fecal coliform bacteria. Private wells are required to be tested for coliform bacteria upon installation, but once approved are not subject to resampling.

The Virginia Tech survey showed widespread presence of coliform bacteria. Of the 143 household systems, 84, or 59 percent, tested positive for these bacteria. The results of this study were considered confidential and neither individual analyses nor sampling locations were released. Because of these limitations, the data cannot be used for further assessment or planning of remedial activities.

In Glasgow, one of three public supply wells tested positive for coliform bacteria in 1999 resulting in the abandonment of the well, because of the well issue, Glasgow embarked upon a water improvement project that was completed in 2015. The project made many improvements to the quality of drinking water and system wide water loss was reduced by 50%, as well as a 50% reduction in water losses throughout the water system. Additionally, improvements to the fire hydrant system increased ISO rating for homeowner's insurance policies, improvements on cutting water off in sections of town vs. cutting the whole town water system off, new valves and new water lines, new water blow-off to increase better water quality, energy-reduction in power usage at the two (2) wells and water storage tank, reduction of chemical costs at the two (2) wells and water storage tank, better water quality in storage tank with PAX tank mixer, increased water pressure throughout the whole town, ability to view water system in LIVE operations from remote locations, prepared for emergency on a 24/7 basis vs. reacting to emergency afterwards, better utility billing for services, pay only for your usage vs. paying for others wasting water and leaking pipes. The water project also allowed for a more efficient billing system and tracking of water usage.

Similarly, the presence of bacteria in water from a Buena Vista public supply well in 2011 caused it to be disconnected. The issues has since been corrected and the well is back online. A new treatment facility is needed, and the City of Buena Vista is currently working on plans for constructing a new facility.

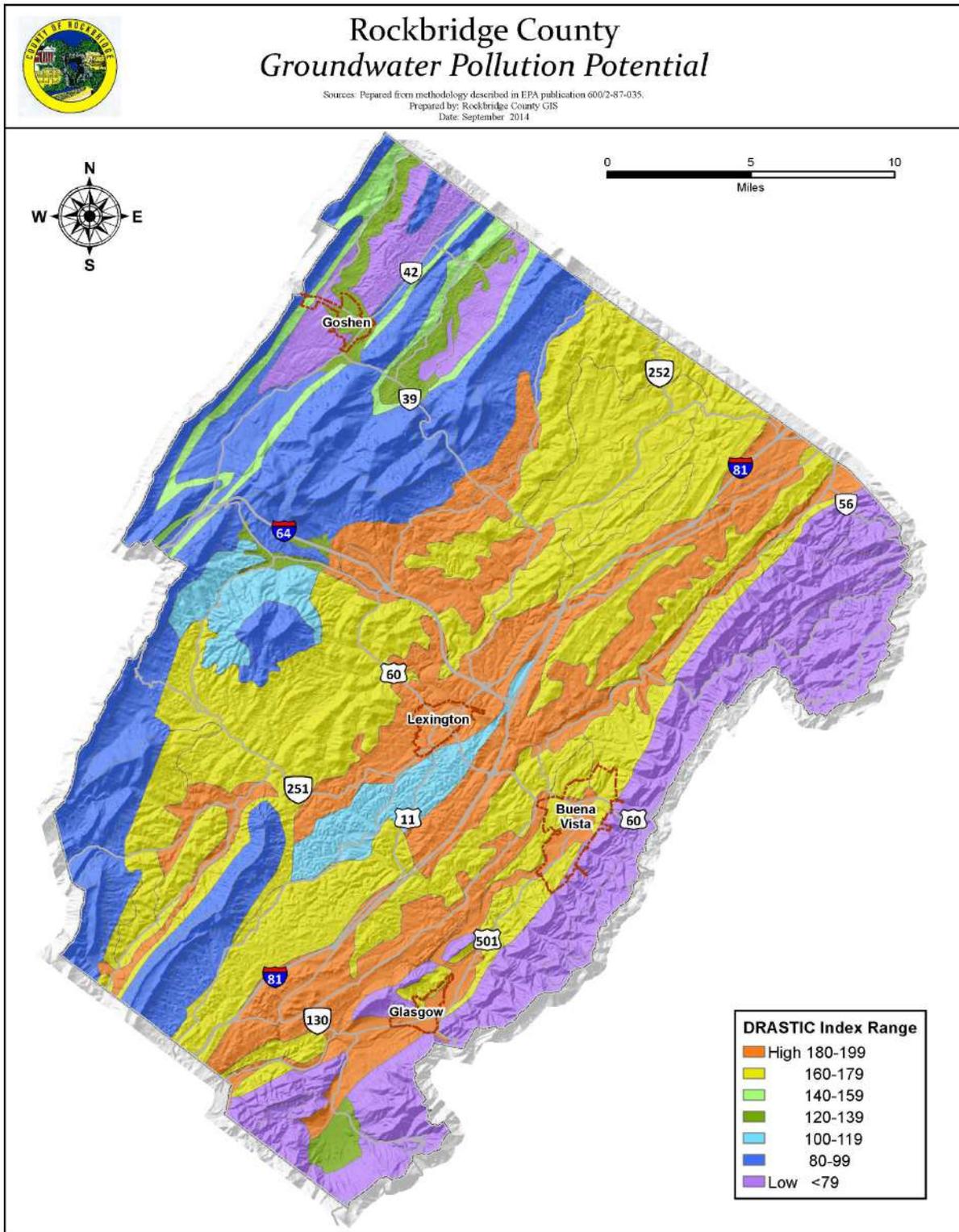
As pointed out earlier, because of widespread presence of limestone and dolomite aquifers in the valley portion of the county the threat of groundwater contamination is significant. Karst conditions with sink holes, caverns and other solution openings in the bedrock provide easy access for pollutants to enter the subsurface and the groundwater reservoir. Once in the aquifer these contaminants can quickly travel and spread to water wells. Except for one study of illegal

dumps (Slifer, 1987) and groundwater monitoring at the County's landfill, no investigations of actual potential sources of groundwater pollution have been carried out in the County.

A map of Rockbridge County showing the groundwater pollution potential prepared by the Central Shenandoah Planning District Commission in 1990 (Map 2.10), indicates that 70 percent of the County's aquifers are very vulnerable to pollution from activities on the land surface. This map, also known as the "DRASTIC map", ranked the pollution hazard of various geologic units based on depth of water (D), recharge (R), aquifer type (A), soil characteristics (S), topography (T), impact of the zone of aeration above the water table (I) and the hydraulic conductivity of the aquifer (C). The sum of assigned values for each of the parameters was used to arrive at a hazard ranking which is portrayed on the map. The higher the ranking number, the higher the pollution potential is.

Among sources of contamination, those of particular concern in Rockbridge County are: landfills, dumps, septic tanks and drainfields, land spreading of sludge, animal waste, leaking underground tanks, hydrocarbon and chemical spills and leaks, waste lagoons, excessive application of pesticides and synthetic fertilizers, highway deicing salts and improper construction and maintenance of water wells.

Map 2.10



Sludge

A potential source of both groundwater and surface water pollution is land-applied sludge from industrial or sewage treatment plants. Sludge or biosolids can be a good source of nutrients for crops when properly applied and many farmers welcome the availability of this resource as a cheap fertilizer. However, there are also drawbacks, primarily the unknown nature and chemical composition of the sludge and its potential harmful and toxic constituents. Given the widespread presence of karst conditions in the County, pollutants can easily move underground to the water table and springs or streams. The present regulations for land application of sludge require a soil type survey, a minimum of 18 inches of soil and a buffer zone of 50 feet between application and a sinkhole. Restrictions also apply to food crop harvesting and grazing by animals, as well as public access to the site.

In Rockbridge County, sludge originating from the Maury Service Authority, Glasgow sewage treatment plants and Houff's Feed and Fertilizer Company is applied to various permitted sites. Houff's is an industry based in Augusta County that processes waste from chicken and turkey plants. In 2011, these three facilities deposited 280 tons, or 560,000 lbs, of sludge on some 35 sites, 30 of them located east of I-81. Houff's produced the bulk of this material, or some 170 tons, spread on fields north of Fairfield.

Inspection of DEQ records show that a water pollution case involving sludge occurred in April, 2010 at Big Springs. Sometime following a sludge application on a field, some 1,800 feet northwest of the lake, a white plume was observed entering the water combined with an oily sheen. Along the shore a considerable algal bloom was noted. It was believed that either soluble sludge components entered the limestone bedrock aquifer and were transported to the lake, or fluids entered a shallow drainage ditch that led to the lake. Sludge application was stopped on the field in question.

Leaks and Spills

Regionally, the most serious threat to the County's groundwater supply is from leaks and spills along the I-81 and I-64 corridors. Truck refueling depots handle large quantities of gasoline and diesel fuel and many contamination incidents have been reported. Spills and accidents involving hazardous materials have occurred along these heavily traveled roads and will continue in the future. It is unfortunate that practically the entire I-81 corridor lies within limestone terrain highly vulnerable to pollution.

An examination of DEQ data on water pollution incidents in the County from 2006 to 2012 indicates that there were some 100 cases of spills and leaks of diesel and gasoline fuel along Interstate 81. Most of these spills were caused by accidents and wrecks involving trucks. Volumes of diesel fuel released ranged from 10 to 1,500 gallons. In addition, there were many accidental releases from tank overfills and spills at the truck refueling stops. Only a small portion of all these releases was recovered, and it is believed that most of the hydrocarbons entered the soil subsurface.

Hydrocarbons are among the most difficult fluids to be removed once they enter the subsurface and groundwater. Even trace amounts of petroleum products in groundwater render potable water objectionable because of taste and odor.

Federal action against leaking underground storage tanks and strict rules about construction, maintenance and monitoring have greatly reduced the number of failing and leaking tanks. Yet there still are gas stations that experience leaks and spills that require remedial actions. The DEQ presently (February, 2012) is overseeing monitoring well programs at Lee Hi Travel Plaza, Natural Bridge Shell and Ferguson Grocery in Natural Bridge where spills have taken place.

FOREST RESOURCES

Forest vegetation is an important consideration in land use planning, a sensitive indicator of overall environmental conditions and a vital base for the maintenance of watersheds, forest industry, wildlife habitat and outdoor recreation. According to recent surveys by the Virginia Department of Forestry, nearly two-thirds of the total area of Rockbridge County is forested.

Nearly all the mountainous sections of the County are covered with forests, most of which are second growth. In the valley, except on hills, ridges and steep areas near streams, the forests have been cleared for cultivation and pasture. As shown in Table 2.10, the predominant forest type in the county is oak-hickory, which comprises almost 83 percent of the total forest land. The only other significant forest type in the County is the oak-pine type, which comprises approximately 9 percent of the forest land. In general, the forests in the mountainous western part of the County consist of white oak, northern red oak, southern red oak, eastern white pine and pitch pine, and in the Blue Ridge Mountains the trees are scarlet oak, chestnut oak, white oak, pitch pine, spruce pine, blackjack oak, poplar, hickory and white pine. In the valley, the predominant tree is white oak, and other trees are northern red oak, hickory, cedar, locust, few post oak and walnut. Along the valley streams, the most common tree is sycamore, and other common trees include willow, ash, basswood, beech, birch, elm and walnut. Alder bushes also grow here. Dogwood and redbud are conspicuous flowering trees throughout the County in the spring.

Invasive, exotic species continue to be a growing threat to native forests. These plants generally grow quickly, have prolific seed production or sprouting ability and compete for resources better than our native trees. Invasive species rarely have commercial value and generally low wildlife nutritional value as well. Some of the species found widely in Rockbridge County include, *Ailanthus altissima* or paradise tree, autumn olive, multiflora rose, privet, bush honeysuckle and Japanese honeysuckle. The cost of control for these species can be extravagant, and the loss of forest productivity by the presence of these species constitutes a reduction in monetary and wildlife value for the forest landowner.

Table 2.10 Forest Type Data 2009-2014

Rockbridge County	Acres	Percent
White/Red/Jack Pine	1,523	.57
Loblolly-Shortleaf Pine	1,335	.50
Other Eastern Softwoods	12,371	4.64
Oak/Pine	24,083	9.04
Oak/Hickory	218,976	82.17
Maple/Beech/Birch	4,215	1.58
Aspen/Birch	2,672	1.00
Nonstocked	1,335	.50
Total	266,510	100

Source: USDA Forest Service FIDO database-<http://apps.fs.fed.us/fido/standardrpt.html>; 2009-2014

Ownership of commercial forest land in Rockbridge County is approximately 35.5 percent public. The George Washington National Forest, the Jefferson National Forest, the Goshen Wildlife Management Area and the Little North Mountain Wildlife Management Area account for most of this public ownership. The remaining 64.5 percent of the commercial forest land in the County is privately owned. Woodlots owned by farmers and private individuals account for a large portion of this land, with forest lands owned by forest industries and corporate land making up the remainder.

Total sawtimber growth in Rockbridge County exceeds the cut by a two to one ratio, while the growth of all growing stock exceeds the cut by slightly less than two to one ratio (see Table 2.11). Both of these ratios are influenced by the small size of timber present. Sawtimber volumes are present in the small sawtimber sizes and the annual cut will increase when these stands grow into larger and more desirable timber. Over 40 percent of the forest acreage supports pole size stands which are chiefly hardwoods. With this supply available and an available hardwood pulp market at Covington, fairly small hardwoods can be cut. Good markets exist for all forest products - veneer, pulpwood, sawtimber and cooperage stock.

Table 2.11 Estimated Average Annual Net Growth and Cut, 2009-2014

Species Groups	Growing Stock		Sawtimber	
	Growth	Cut	Growth	Cut
Pines	1,077,467	1,563	8,116,364	486,131
Eastern Hemlock	-119,051	-	75,359	-
Other Eastern Softwood	531,001	33,229	2,786,013	-
Oaks	3,412,730	1,466,338	16,756,992	6,025,854
Hickory	662,338	69,348	3,960,020	-
Maples	566,620	-	1,859,974	-
Beech	127,059	-	312,075	-
Tupelo/Blackgum	127,059	34,199	522,149	-
Ash	189,120	-	823,631	-
Yellow Poplar	3,078,267	547,952	15,157,814	2,044,168
Walnut	73,327	-	157,835	-
Other Eastern Soft Hardwood	223,199	-	520,146	-
Other Easter Hard Hardwood	15,203	-	-	-
TOTAL	9,964,339	2,152,629	51,048,372	8,556,153

Source: USDA Forest Service FIDO database-<http://apps.fs.fed.us/fido/standardrpt.html>; 2009-2014

*Per Thousand Cubic Feet

Major forest management needs in Rockbridge County according to the Virginia Department of Forestry are: (1) stand improvement to increase the percentage of desirable species; (2) harvest timber to improve the health of a forest stand; (3) intensive forest management for pole size stands of timber on the better sites; (4) control "involuntary forestry" created by treating trees as by-products of other endeavors on the land rather than as a primary resource; and (5) control exotic, invasive species in forest stands.

Forest fires seem to be fairly well controlled in the County through an extensive educational campaign and the excellent cooperation of local fire departments with the Virginia Department of Forestry, the US Forest Service and the Park Service. Though the county experiences larger

wildfires every few years, many years see less than 100 acres burned per year. The largest fire in Rockbridge County history burned in 2012, a fire that started on the Rich Hole Wilderness area in Western Rockbridge County and spread to US Forest Service and private land in Rockbridge, Alleghany and Bath Counties. The fire covered 15,400 acres of land, approximately 500 of which was private land in Rockbridge County.

Rockbridge County receives a number of economic benefits from its woodlands - some direct and some indirect. Rockbridge County traditionally receives an annual payment from the Federal Government to partially compensate for the tax immunity of federally owned National Forest land within the County. In Fiscal Year 2014, the County received \$89,784 in compensation. According to the Virginia Department of Forestry, stumpage value of forest products sold in Rockbridge amounted to approximately \$3,642,437 in 2014. In addition, a significant number of persons are employed by logging companies and sawmill operations. The use of forests and streams for direct recreational purposes such as hunting, fishing, camping and hiking brings hundreds of people into the County yearly.

WILDLIFE RESOURCES

Rockbridge County's extensive deciduous forest in combination with open farmland and abundant surface waters provide excellent habitat for a wide variety of wildlife. Good populations of both game and non-game species are found in the County.

The white-tailed deer is the most abundant big game animal found in the County. These animals, which inhabit both forest and field, have stabilized their numbers over past years. As reported by the Virginia Department of Game and Inland Fisheries, deer harvests for the 2011 to 2015 seasons are found in Table 2.12. Rockbridge County has a healthy deer herd and very good deer population levels. The statewide Deer Management Plan can be found on the Department of Game and Inland Fishery website <http://www.dgif.virginia.gov/wildlife/deer/management-plan/>.

Wild turkey is also found in abundance in Rockbridge County. The County's large acreage of mature woodland and open lands provides excellent habitat for the wild turkey. The statewide Wild Turkey Management Plan can be found on the Department of Game and Inland Fishery website <http://www.dgif.virginia.gov/wildlife/turkey/management-plan/>. The turkey harvest for the 2011 to 2015 seasons are found in Table 2.12.

Portions of Rockbridge County offer excellent habitat for the black bear with forested mountain habitats and productive farmlands. Black bear populations are at record levels in recent years statewide and the black bear population in the County is high. The black bear harvests for the 2011 to 2015 seasons are found in Table 2.12. The Department of Game and Inland Fishery Bear Management Plan can be found on their website <http://www.dgif.virginia.gov/wildlife/bear/blackbearmanagementplan.pdf>. Primary small game species in the County are squirrel, ruffed grouse, rabbit and quail. Squirrels are found in large numbers in the County, with both fox and gray squirrels being present. Grouse populations are not as abundant as in previous years but still provide good hunting in comparison with

surrounding counties. Rabbit and quail populations are found throughout the county, although at lower levels than several years ago. There has been a significant loss of good habitat in recent years, due to more efficient farming techniques and land development, which leave less cover and "wasteland" for habitat.

Table 2.12 Rockbridge County Game Harvests for Hunting Seasons, 2011-2015

Game	2011	2012	2013	2014	2015	Five Year Average
Deer	2,471	2,624	2,641	2,084	2,592	2,477
Black Bear	94	76	83	129	79	461
Turkey - Fall	51	140	79	61	68	80
Turkey – Spring	297	246	302	402	338	317
Total Turkey	348	386	381	463	406	397

Source: Department of Game and Inland Fisheries, Annual Reports.

Although the coyote is not native species of Virginia, they have been found throughout the Commonwealth since the 1950s. Coyotes are about the size and weight of a medium-sized dog and generally have longer and thicker hair (ranging from blond, light reddish-brown, tan, grayish black or black with a small white blaze in the center of the chest), with a tail that is bushy and pointed downward and ears are pointed and erect, and the snout is relatively long and slender. The coyote population is more abundant in counties west of the Blue Ridge Mountains. The coyote is legally classified as a nuisance species and may be killed at any time, except coyotes may not be killed with a gun, firearm, or other weapon on Sunday.

Non-game animals frequently found in the County include skunk, woodchuck, opossum, songbirds and predatory birds. Streams, ponds and river bottoms are frequented by muskrats, otter, woodcock, ducks and other water fowl. In several regions beaver populations are flourishing.

Rockbridge County's many aquatic features contain both warmwater and coldwater (trout) fisheries. The James River, the Maury River, lower Buffalo Creek and lower South River supports healthy populations of smallmouth bass, sunfish, rock bass and catfish. Flatwater is limited, but Lake Robertson is a local destination for largemouth bass, bluegill, redear sunfish and channel catfish. Occasionally, black crappie and walleye are caught from its waters. Mountains that form the eastern and western borders of Rockbridge County are laced with numerous wild trout streams. Native brook trout populate waters such as Guys Run and Irish Creek. Brown trout and rainbow trout fingerlings are stocked into Buffalo Creek annually. Brook trout fingerlings are introduced into Lexington Reservoir, a walk-in fishery, once a year. Larger brook, rainbow, and brown trout are stocked several times a year in Goshen Pass, Mill Creek,

South River and Irish Creek. There are no animal species in Rockbridge County that are threatened or endangered.

LANDSCAPE RESOURCES

The attractive landscape of Rockbridge County is a valuable natural resource. For many residents and visitors, the land has a special look that not even surrounding counties can match, even though many of the same features are present.

The Blue Ridge Mountains are an attractive backdrop for the eastern part of the County, especially Buena Vista and Natural Bridge. The George Washington and Jefferson National Forests, South River and Irish Creek, the Maury and James Rivers and a variety of mountain peaks have made for spectacular scenery. The Blue Ridge Parkway, the parallel Appalachian Trail, Cave Mountain Lake, trout fishing and private and public camps are some of the uses already made of the scenery.

The Alleghenies to the west have added landscape quality to the County. Little North Mountain, Jump Mountain, Hogback Mountain, House Mountain and Short Hills stand out from the main ridges of the mountains to form familiar landmarks. The George Washington and Jefferson National Forests, the Maury River, especially at Goshen Pass, Guy's Run and the Calfpasture have numerous cabins and camps for outdoor recreation.

The Valley of Virginia, which runs roughly north and south, is cut by many ridges running parallel to the mountains. While this has made farming and transportation difficult, it has made the landscape more varied. Many hill and ridge tops afford spectacular views, and many houses are now built on these tops to take advantage of the scenery. The ridges have tended to keep local communities small and united, which has made the County a desirable place to live.

Agricultural patterns have added to the visual quality of Rockbridge County. National Forests have produced solid, unified forests in the east and west ends of the County. The return of many ridgetops to woods within the valley and the change to large blocks of grazing land has resulted in a pleasantly "natural" look in Rockbridge County.

The Maury and James Rivers have added a different look to many parts of the County as well. The often spectacular views along the rivers have encouraged the development of homes, scenic drives and recreational facilities. Many of the same comments apply to tributaries such as Buffalo Creek, Brattons Run, Calfpasture River, Walkers Creek, Kerrs Creek and South River. Fishermen and hunters use many of the smaller waters for their sports as well. Large estate homes and churches reflect the agricultural history of Rockbridge County and add another pleasant feature to the landscape. Although no longer functioning resorts, Rockbridge Alum Springs and Rockbridge Baths were mineral springs of a unique quality. The dams and locks along the Maury River are another reminder of an earlier day, as are the old mills and former railroad beds.

The Maury River, known as the North River in canal days (1800-1880), was an important commercial waterway. The river was modified for bateau navigation by the installation of locks, dams and canals over a distance of 20 miles. Many of its impressive stone locks and massive dam abutments can still be seen and are well worth continued efforts to preserve and protect them for future generations. The canal system was eventually replaced by a railroad, much of it laid on the old towpath. In 1979, seven miles of the railway line were donated to Virginia Military Institute by the Chesapeake and Ohio Railway. This is now the Chessie Nature Trail between Lexington and Buena Vista, passing by four of the old locks and dams. The Rockbridge Area Conservation Council issued a guide to this trail in 1987.

Historical sites marked by tablets include the birthplace of Sam Houston, Cyrus McCormick Farm, Timber Ridge Church, Liberty Hall Academy origins, McDowell's Grave and Homesite, Cherry Grove Estate, Thornhill Estate and Matthew Fontaine Maury's Grave. Lexington, in the middle of Rockbridge County, has many historic buildings and sites.

All of the County's State-maintained roads have been named in connection with establishing an E-911 emergency service. The Rockbridge Historical Society published its second version of "*Roads of Rockbridge County*" in 2009. The booklet contains maps and describes the history and origin of the names of county roads.

NATURAL ENVIRONMENT GOALS

GOAL: Protect and preserve the scenic beauty and environmental quality of the County.

Objective: Ensure that mining, silvicultural and development projects are designed so as to minimize the impact on the natural environment and view sheds.

Strategy

1. In all site development, the natural features of the land, such as native ground covers and trees, should be preserved for conservation and aesthetic reasons.
2. On steep mountain slopes, mining of minerals, clear cutting of timber and development is discouraged.
3. Visual and environmental impact should be considered in permitting mining operations.
4. The County should investigate ways to preserve the wild and scenic character of its rivers and streams.
5. Maintain the protected status of the Goshen Pass area, the Rich Hole area and other fragile and scenic areas within the County.

6. With the assistance of appropriate groups and agencies, the County should identify fragile and scenic areas to protect and preserve.
7. Power lines should be confined to existing corridors where possible, and consideration should be given to use of underground lines. Possible impacts of power lines on human health and scenic quality should be taken into consideration as well.
8. Cluster developments with green belts and development below the crest of hills should be encouraged.
9. The scenic quality of the County's road corridors should be preserved through available programs and legislation.
10. The County should continue its educational program to publicize the importance of litter control and to maximize recycling efforts.

Objective: Meet Federal and State standards for air and water quality in all areas of the County.

1. Work with the Department of Environmental Quality (DEQ) to establish a permanent air quality monitoring station in the Lexington/Buena Vista area.
2. Work with State and local organizations to develop a surface and groundwater monitoring program.
3. All public sewage systems should comply with the effluent requirements of Public Law 92-500 secondary treatment levels or water quality standards as appropriate.
4. Continue to enforce the County Erosion and Sediment Control Ordinance.
5. Encourage new development around existing population centers where both public water and sewer service, and other community facilities, are provided or are planned.
6. Development along the footslopes of the Blue Ridge Mountains and other areas should be carefully managed through appropriate ordinances in order to preserve the groundwater resources of the area.

Objective: Ensure that septic tank effluent, solid waste, chemicals, agricultural waste and other pollutants do not contaminate the groundwater supply.

Strategy

1. Develop a wellhead protection program to safeguard public water supply systems.

Objective: The limitations of natural features such as air, water, slope, geology, soils and natural habitat should be recognized when considering residential, commercial, industrial and agricultural growth.

Strategy

1. Areas within the one hundred year floodplain should be designated for agriculture, forestry, recreation and other such uses not requiring permanent structures.
2. Development should be controlled in areas where the natural land slopes are greater than 15 percent. On slopes greater than 25 percent, residential development should be discouraged.
3. Development in karst areas should be regulated in order to reduce the hazards of ground subsidence and collapse and the hazard of groundwater pollution through development and implementation of a comprehensive sinkhole ordinance.
4. Watersheds above public water supply sources should be protected to the maximum extent possible.
5. Because of the common occurrence of stagnant air conditions in the County, land uses that generate high air pollutant discharge should be discouraged.
6. Potential natural resource sites should be identified and managed for sustainable use.
7. Agricultural soils of highest local quality should be identified and preserved as an important natural resource.

Objective: Ensure that large areas of the County are maintained as open space for future local, State and national needs for agricultural and wood products, recreation, water supply and quality of life.

Strategy

1. To maintain an extensive and healthy forest base, the County should continue preferential land use taxation and encourage landowners to use sound forest management practices and to form Agricultural and Forestal Districts.
2. Reforestation of idle lands should be encouraged. Land owners should be encouraged to utilize available cost-share programs through the Virginia Department of Forestry and United States Department of Agriculture.
3. The County should encourage designation and preservation of critical environmental areas and endorse the State's forest management plan for Rockbridge County.