Natural Resources

Introduction

The impact of future growth and the correction of past actions that now affect the environmental quality in Warren County have become an issue of increasing public concern. The effects of increased population and economic development affect the natural environment in many ways. These include: clearing of trees and natural vegetation, loss of plant and wildlife habitat, loss of valuable wetlands and aquatic habitat, ground water contamination, degradation of surface water quality in streams and rivers, disruption of natural water drainage systems, air pollution, increased amounts of solid wastes, and degradation of scenic natural views.

Environmental deterioration need not be an inevitable consequence of population growth. The development of new homes, businesses, industries, schools, and roads necessary to accommodate a growing population can occur without unduly threatening the County's natural resources if steps are taken to improve existing developed areas and to ensure that new development is designed, built, and located in an environmentally sensitive manner. Certain Warren County areas are much more susceptible to environmental degradation than others due to the presence of fragile natural features. Future development should be directed away from sensitive areas and guided to County areas where environmental impact can be satisfactorily accommodated. Regardless of location, all future development should exceed the minimum performance standards from the Federal and State requirements for protection of the County's natural resources.

Physical and geological factors affect Warren County's natural resources and environment. To fully understand Warren County's relationship to other counties within the Northern Shenandoah Valley Region refer to **Map 3.1**. This map illustrates the County's location in the Northern Shenandoah Valley.

Background Information & Natural Resource Quality Issues

Characteristics of the natural environment affect development in varying degrees. While some natural features encourage and enhance development, others correspondingly limit certain land uses and development intensity.

By examining the land's natural features, including surface forms, surface and sub-surface hydrology, geology, soils, and drainage areas can be designated where future development should be encouraged or restricted. Poorly located development can have lasting negative effects on the environment. Through proper planning, Warren County can protect its natural resources and ensure that growth occurs in harmony with the land's ability to sustain development.

Warren County is blessed with great natural beauty, due in large measure to the Shenandoah River, Blue Ridge Mountains on the east and the Massanutten Mountains on the west, plus a predominately rural character. Natural resources include soils suitable for a variety of agricultural activities, forests on both government owned and private lands, good watersheds, numerous streams, the Shenandoah River, an excellent variety of wildlife, and reasonable air quality.

However, the County is under increasing development pressure. Watershed areas and slopes now being developed are subject to erosion and are marginally suited for septic tank systems. A wide belt of karst terrain runs north-south through the center of the County. Natural vegetation belts along streams are decreasing causing a loss of filtering and erosion control qualities. Strip development is creating additional traffic and is contributing to the degradation of views and vistas enjoyed by local residents and tourists, alike. In the search for much needed industry, great care must be taken to avoid activities that would add to air or water pollution. There is a need to protect the community's air quality. Thus, it is imperative that environmental considerations and performance standards be applied to all future development in the County if it is to keep those characteristics that make this a pleasant place to live and which can attract the quality and variety of industry needed for a balance in development and tax base.

The average annual precipitation is 40 inches of rainfall and 21 inches of snowfall. The temperature is an average low of 35° F during January and an average high of 85° F during July. The mean date of the last spring freeze is April 26, and the mean date of the first fall freeze is October 13. The average growing season is 170 days. Although this part of Virginia normally has abundant rainfall, the

frequency of dry periods and droughts greatly affects agricultural activity. Prevailing south and southwest winds average a velocity of ten miles per hour.

Section 1: Topography

An area's surface features affect the development type and cost, soil erosion, the direction and rate of storm-water run-off, flooding, and the landscape's visual quality.

Warren County is bounded by the Blue Ridge Mountains on the east and the Massanutten Mountains on the west. The Blue Ridge Mountains are the highest, averaging 2,700 feet above sea level throughout the County. The lowest elevations are found in the north (1,925 feet at the Clarke County line) and the highest in the south (3,460 feet at the Page County line). The Massanutten Mountains average 2,000 feet above sea level with the highest elevations in the north (2,106 feet on Signal Knob) and the lowest in the south (1,860 feet at the Page County line). These two mountain ridges visually dominate the County's landscape, looming 1,000 to 2,900 feet over the central lowland. Topography in these mountainous areas includes steep-walled valleys with fast flowing streams and wooded slopes. The County's central and northeastern parts, underlain by shale, limestone, and dolomite, form a valley with moderate to gently sloping terrain.

The following five categories define slope areas within the County and describe the development potential of each. In any one category it is possible for slopes to vary greatly. The majority of land in each category will have a slope within the described limits. **Map 3.2,** shows the location of the major slope categories.

Flat terrain is land having a slope of less than three percent. It includes the floodplain of the Shenandoah River. Development in these areas should be prohibited because of drainage problems caused by the negligible slope and because of the high probability of flooding. Warren County has 5,940 acres, or 4% of its total land area, in the 0-3% slope category.

Gently sloping land ranges from a 3% to a 7% slope. This land is suitable for all forms of development, but particularly for industrial, commercial, and public (institutional) uses because the gentle slopes provide good drainage without posing construction problems. The gently sloping land is located in the central and northwestern part of the County. The 3 to 7% slope category covers 63,358 acres, or 47% of the total land area.

Moderately sloping land ranges from a 7-15% slope. These areas are well suited for single-family, detached residential development; however, the steeper the slope (especially over 12%), the greater the problems that will arise during construction and site development. Moderately sloping land is found in the Browntown area and along the boundary of the George Washington National Forest. Warren County has 26,668 acres, or 19% of its total land area, in the 7-15% slope category.

Steeply sloping land ranges from 15-25% slope. Development in areas with this slope becomes costly and difficult. Steeply sloping land extends along the boundary of the Blue Ridge Mountains. The County has approximately 18,296 acres, or 13% of its total land area, in the 15-25% slope category.

Excessively sloping land includes land ranging from 25-45% slope. This land is found within the Massanutten Mountain range along the southwestern boundary of the County and within the Blue Ridge Mountains along the County's eastern boundary. Warren County has 22,898 acres, or 17% of its total land area, in the 25-45% slope category.

Map 3.1: Regional Location

Implications of Slope: Home Construction

The large areas of the County with steep terrain present severe development problems. The mountain scenery provides an ideal setting for the building of summer cottages and retirement homes. However, these same areas are most subject to erosion and least suitable for septic tank installation. Residential structures should not be built on slopes greater than 25% without meeting special standards stipulated by the Building Inspections Department and giving due consideration of other possible environmental problems. Slopes between 15% and 25% should be developed at very low density under strict regulations to include erosion control/groundwater protection and a complete site plan with performance standards. New development in these areas should be restricted to two or more acres.

As much as the County's hillsides may be admired, they are becoming progressively more threatened. Construction in areas of lesser slope is obviously easier, less expensive and secure from the threat of landslides and severe drainage problems. However, as valley and upland sites available for development become more scarce, and as more and more people are able to afford view properties, there is increasing pressure for development on slopes and hill crests. This pressure also poses the threat of degrading the dramatic visual character afforded by our wooded hillsides.

Map 3.2: Generalized Slope

What exactly needs to be done to protect the hillside? First, we must recognize that not all hillsides are alike. A few are so prominent, attractive, or fragile, that they should be preserved in their natural state. Many others, however, are suitable for development, provided it is carried out sensitively within acceptable limits and under rigid standards.

This raises a series of very critical questions. How do we assess the relative visual quality and environmental significance of hillsides in Warren County? How do we relate these distinctions to varying degrees of vulnerability to drainage and development? Where hillside development can be sensitively undertaken, what are appropriate guidelines? Finally, which hillside areas deserve priority attention?

Implications of Slope: Industrial/Commercial/Other Development

Industrial and commercial land uses should be located on gently sloping land, preferably with no more than a 7% slope that is capable of being graded without excessive expense. Public land uses, such as schools, churches, hospitals, and cultural facilities should also be located on slopes of not more than 7%. Although residential land uses can be located on a variety of terrain including fairly level, rolling, and hilly sites; steep sites and very level, low or poorly drained areas should be avoided. According to use, many recreational activities have minor limitations as to slope and often include land not practical for other uses. Picnic areas or the growth of appropriate crops could be located in low lying floodplains, while hiking trails may extend up steep mountain slopes.

Section 2: Scenic Attributes - Views and Vistas

The tourist industry is a major element to Warren County's economy. As a result, views from Skyline Drive and vistas along County roads are critically important. These visual resources, which provide desired rural character for tourist and resident alike, are increasingly threatened by traditional development patterns. Strip development and clear cutting of timber land and building sites are the greatest threats. Such practices hide or deface views, open the land to erosion, destroy animal habitat and erase seasonally colorful growth. The basic aim is, how can the County change development patterns to preserve visual resources while allowing landowners reasonable flexibility of use while maintaining and even enhancing value.

Implications of Cluster Development

Cluster development can provide increased density; make it easier to provide services; and take advantage of the best orientation for dwellings/buildings regardless of the direction of adjoining County roads. This type of development retains rural character by preserving woodland and greenways. By encouraging/requiring such development, the infrastructure and associated development costs will be

lower. Cluster development will permit more units relative to acreage while retaining the natural character of the property and reducing the number of outlets to adjoining roads.

Implications of Reduced Clear Cutting

On a building site, clearing only the area necessary for construction and related amenities retains natural drainage patterns, reducing potential for erosion. Keeping mature greenery can provide immediate beauty from adjoining areas and within the site, while reducing the need for new planting. This provides immediate aesthetic and potentially monetary value.

Selective cutting of forest areas for lumber or firewood leaves growth necessary to prevent erosion, and retains the basis for natural reforestation. While allowing profit from the timber, this practice significantly increases the land's value as building sites, or for future timber harvest. Reasonable controls should be formulated to reduce exploitation of forest land.

Hiking and Bike Trails

The County has started the development of hiking and bike trails adjoining scenic areas along County roads. The hope is that this will draw increased numbers of people engaged in health and enjoyment pastimes. The use of existing right-of-ways, or passage through government owned land helps to reduce development costs. Connecting such bike trails to local community focal points such as parks, schools, and other facilities would provide a safe means of access to these community facilities. This would provide tourists with a scenic route to observe the natural beauty of Warren County and would result in less local traffic on County roads.

Section Three: Soils

A detailed soil survey for Warren County has recently been updated by the USDA Soil Conservation Service. This survey is the County's best source for detailed site data on soil development constraints. **Map 3.3**, shows generalized areas where soils are not suitable for septic fields. Many of these soil constraints are related to septic limitations which can be overcome by central sewer service. Copies of the Warren County Soil Survey are available for inspection in the Warren County Planning Office.

The area's soil composition is another factor determining natural development potential. The three major divisions of soils in Warren County are the Massanutten Mountains in the west, the shale and limestone areas of the central County, and the Blue Ridge Mountains and foothills in the eastern part of the County. The location of soil associations for Warren County are shown on the general soil map of **Map 3.4**. The major soil associations in the County include: lodi-endcav, carbo-rock, outcrop-chilhowie, unison-chagrin-dyke, berks-blairton-weikert, berks-weikert-sequoia, and myersville-montalto-lew.

Map 3.3: Soil Suitability for Septic Systems

Implications of Soils: Septic System Suitability

The suitability of sites for septic systems is a major factor in deciding future land use where central waste treatment facilities are not available. Eight elements determine this suitability. These elements are: depth to water table, flooding, slope, depth to bedrock, presence of stones, percolation rate, clay content, and the existence of coarse fragments which would create potential landslides. These elements are used to determine areas having severe septic tank limitations.

Warren County has moderate to severe limitations for the use of septic systems. According to a recent soil study performed by the U.S. Soil and Water Conservation Service, 51% (71,522 acres) of the County has severe restrictions for septic systems. Moderate to severe limitations exist on 32% (43,727 acres) of the land and moderate limitations are found on 17% (24,911 acres) of the County.

Implications of Soil: Agricultural Suitability

Prime farm land, as defined by the U.S. Department of Agriculture, is that land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce sustained high crop yields if acceptable farming methods are used. Prime farm land produces the highest yields with minimal inputs of energy and money. Farming such land results in the least damage to the environment. Prime farm land is of major importance in satisfying the nation's short and long-range food and fiber needs. The supply of high quality farm land is limited and it must be used with wisdom and foresight.

Map 3.5, illustrates the suitability of soil for agricultural purposes. The Soil Conservation Service has divided the County into four categories, describing and assessing each as follows:

The first category is the Central Warren Valley. It extends through the center of the County from the southern to the northern borders. It covers 63,170 acres, or about 45% of the County. The soils, overlaying limestone and dolomite with terraces and small colluvial areas in the southern portion, are deep, well drained, flat to sloping, and are generally well suited for all types of agriculture. Some small areas have rock outcrops, wetness, and overflow limitations. Cobbles found in the southern part may hinder cultivation. The area is used primarily for livestock production. Most of the dairy and livestock operations are located here. Hay and tall grasses are grown on the flat lands and on the gentle slopes.

This area also contains the best cropland in the County. At present it is used principally to grow forage crops for livestock. Much of the land could be irrigated from the Shenandoah River to produce high volume crops such as corn and truck crops. About 32% of the area has 7% - 25% slopes that would require intensive treatment. These areas are suitable for alfalfa. Through the creation of the Rockland Agricultural

and Forestal District, approximately 9,000 of the 29,500 acres best suited for agriculture have been preserved. The County should support the continuation of this District.

The second category is the Shale Area, located in the western part of the County. It covers 33,657 acres, or about 24% of the County. Soils, ranging from very shallow to moderately deep, are formed from shale and colluvial sandstone. Over 75% are shallow to very shallow droughty soils. Cobbles, gravel, steep slopes, and wetness are also limitations. The majority of the area is in woodland and is best suited for grassland and small grain farming. The better soils are used for hay and the remainder is grazed. Lack of moisture limits the production and the species of grasses and legumes that can be grown. Steep slopes and cobbles are other limitations.

The next category is the Blue Ridge Foothills, covering 28,960 acres, or 21% of the County. The Blue Ridge Foothills are located on the east side of the County and extend from the southern to the northern border. Almost half of the land is in the Shenandoah National Park. Most of the farmers operate on a part-time basis. Soils are well drained and range from deep to shallow and from sloping to steep. They are formed from granite, greenstone, schists, and conglomerates. Some are shallow and droughty. Cobbles, rocks, boulders, and steep slopes are also limitations. The majority of the area is in woodland with only a minimal amount used for crops and pasture. The small amount of cropland found in this area occurs in small, widely scattered patches and is used for hay and grazing. The very limited amount of good grassland occurs in widely scattered patches along the highways. The better soils are used for hay and the poorer soils are used for grazing. A majority of this area has severe limitations due to drought, steep slopes, and rockiness. Treatment by conventional equipment is limited to the flatter slopes.

The final category is the Sandstone Mountains. These mountains cover 14,790 acres, or about 10% of the County. Approximately 5,527 acres are in the George Washington National Forest. Located in the west and northeast section of the County, the area predominately is made up of shallow, steep, quick draining sandstone soils generally unsuited for farming.

Map 3.4: Generalized Soil Types

Map 3.5: Soil Suitability for Agriculture

Section 4: Floodplain

Floodplains comprise approximately 4% of the land area in Warren County due to topographic elevations from 400 feet to 3,400 feet. The primary floodplain area is located adjacent to the Shenandoah River. This area encompasses four separate watersheds; the South Fork Shenandoah, the North Fork Shenandoah, the Shenandoah and the Middle Potomac-Catoctin all of which are included in the Chesapeake Bay watershed. The North Fork, South Fork and Main branch of the Shenandoah River, Happy Creek, Leach Run and the tributary to Leach Run encompass the majority of Special Flood Hazard Areas (SFHA) throughout the County.

The one percent Annual Chance Floodplain formerly known as the 100-Year Floodplain is recognized by federal regulations as the area where the potential for flooding is a significant hazard and where development should be limited or not occur. It is divided into two sections: the floodway and floodway fringe. Federal Emergency Management Agency (FEMA) requirements address the direct aspects of potential damage that can occur if new development takes place in areas subject to flooding. Floodway development is severely restricted by FEMA. The local ordinances should prohibit development in the floodway and institute a setback of 50 feet from the floodway in order to provide additional protection. The floodway fringe areas are moderately restricted and allow for structures to be built one foot above the base flood elevation as determined by the County's Zoning Administrator or local certified Floodplain Manager.

Floodplains or flood-prone areas include any land area susceptible of being inundated by water from any source during a flood event. The Special Flood Hazard Area (SFHA) is the area which has a 1% chance of flooding each year and is identified on the Flood Insurance Rate Maps (FIRM) as being in zones 'A' or 'AE'. The 'AE' zone has the base flood elevations (BFE) determined on both the FIRM and the Flood Insurance Study (FIS), while the base flood elevations in the 'A' zone are not determined.

The floodway is the channel of a stream or river plus any adjacent floodplain areas. This area must be kept free of encroachment so that the one percent annual chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot provided that hazardous velocities are not produced. Although FEMA does not prohibit construction in the floodway, development should be prohibited within zone 'AE' where base flood for the regulatory floodway has been determined in order to avoid any substantial increases in flood heights and to mitigate potentially high losses of property during major flood events. In zone 'A' of the FIRM, base flood elevations for the floodway that have not been determined by FEMA. Data showing the approximate floodway boundary should be submitted by a Certified Engineer or Surveyor to the Floodplain Manager or Zoning Administrator prior to approval for construction of any dwelling or structure.

The area between the floodway and one (1) percent annual chance floodplain boundaries is termed the floodway fringe. Development in the SFHA outside of the floodway in the floodway fringe is restricted and subject to approval by the County Floodplain Manager or Zoning Administrator. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1% annual chance flood by more than 1.0 foot at any point; Reference Figure 1: Floodway schematic.

Shaded Zone X of the FIRM is shown as; the areas of 0.2% annual chance of flooding, areas of 1% annual chance of flood with depths of less than one foot or with drainage areas less than one square mile and areas protected by levees from the 1% annual chance flood. These areas should be the least restricted but should be subject to an elevation certificate for the as-built structure if built within 50 feet of the SFHA boundary.

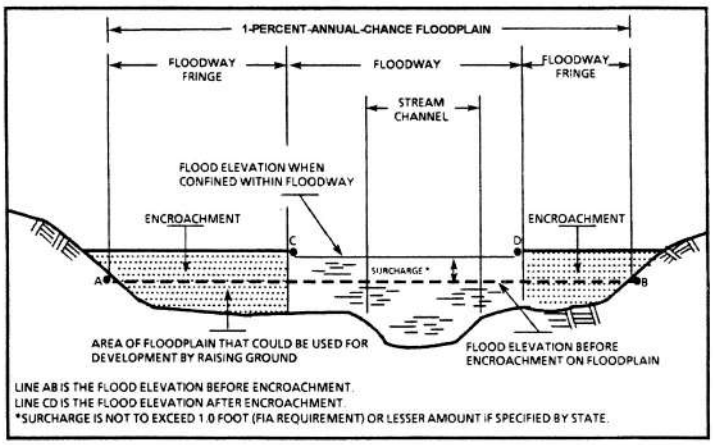


FIGURE 1: FLOODWAY SCHEMATIC

Floodplain filling and development can result in a major loss in the storage capacity of flood waters by altering drainage patterns and cause an increased velocity and volume of runoff.

Warren County should participate in the Community Rating System (CRS) which is a voluntary program with goals to reduce flood damages to insurable property, strengthen and support the insurance aspects of the National Flood Insurance Program (NFIP), and encourage a comprehensive approach to floodplain management. The CRS has been developed to provide incentives in the form of premium discounts for communities to go beyond the minimum floodplain management requirements to develop extra measures to provide protection from flooding.

Any residential structures approved for being built in the floodplain should be required to be floodproofed according to the locally adopted building code. The County should participate in the FEMA's Repetitive Flood Claims and Severe Repetitive Loss grant program to help the National Flood Insurance Program handle properties which not only continually sustain damage during severe weather events but whose claims exceed the overall value of the structure. Structures that are substantially damaged or require substantial improvement will be assessed for current approximate market value by the County Commissioner of the Revenue's office.

Unregulated development in floodplains hinders the important natural drainage existing in such areas and increases the chance of flooding downstream, which can result in extensive property damage. Floodplains should be allowed to remain in their natural state so stream valleys will absorb a large portion of the rainfall, replenish the groundwater supply, and release storm water into streams at a more gradual rate. Hence, a fifty foot riparian buffer along perennial rivers and streams should be required for protection of these resources and reduce the potential of flood damage to structures. Although development should be prohibited within the floodway, this area could be used for agricultural or recreational purposes.

One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard and property damage. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management.

Section 5: Surface Water - Drainage Systems

The Shenandoah River, including both the North and South Forks, is one of the County's most important resources. It provides the major domestic and industrial water supply, a source of power and water for recreation and agriculture, as well as an irreplaceable scenic landscape.

Because of increasing development problems, a storm water management study needs to be initiated by the County. The study should focus on a regional approach to storm water management; from this study a storm water management ordinance needs to be adopted.

Depending on the water resource's size and the location of nearby potential pollutants, all surface waters are susceptible to potentially harmful development effects. These could include: leachate from landfills; suspended sediment from agricultural and development erosion; urban lawn leachate; mining operations (including sand and gravel washing operations); bacterial contamination from failing septic systems and sewage treatment plants; runoff from agricultural fields, residential use of pesticides and herbicides, and impervious surfaces; treated sewage with high nitrogen levels; leaking industrial storage and containment facilities; untreated stormwater from land activities; and dredging operations.

Warren County is drained by the Shenandoah River and its North and South Forks. A fourth stream, Happy Creek, merges at the junction of the two tributary forks, which is the last major drainage basin within the County.

The four basins can be divided into another six minor watersheds (**Map 3.6**). Each of these represents small, but, important streams that drain into the larger basins. The ten major drainage basins are as follows: (1) South Fork of the Shenandoah River, including very small tributaries - 26,575 acres. (a) Cabin Run Watershed - 7,040 acres, (b) Gooney Run Watershed - 17,498 acres (c) Flint Run Watershed - 9,210 acres. (2) Happy Creek - 17,138 acres; (3) North Fork of the Shenandoah River, with very minor tributaries - 11,650 acres, (a) Passage Creek Watershed - 2,307 acres; (4) Shenandoah River and very small tributaries - 27,799 acres, (a) Manassas Run Watershed - 9,325 acres, and (b) the Crooked Run Watershed - 11,618 acres.

Natural drainage and topography are the main factors when planning for storm drainage and sanitary sewerage systems. Whenever possible, sewage trunk lines should follow stream courses and treatment plants should be located at low areas to take advantage of gravity flow system efficiency.

Front Royal has the only municipal sewage treatment plant in Warren County. The Front Royal treatment plant has a permitted capacity of four million gallons per day. However, this plant like many in the country, does not remove nitrogen from its effluent. The water's overall quality is relatively good. Due to the installation of secondary waste treatment facilities at several industrial sites along the South Fork, the installation of more primary and secondary facilities for treatment of municipal wastes, and because of curtailed or abandoned operations such as the tannery in Luray, the river's historic pollution problems have been reduced significantly.

The Virginia State Water Control Board, the Interstate Commission on the Potomac River Basin, the U.S. Fish and Game Commission, Friends of the Shenandoah River, and the local chapter of the Isaak Walton League, have been effective not only in maintaining each new water quality level obtained, but they also have been effective in identifying quality problems as they arise.

A potential water quality problem for the County is the non-point source discharges of high nutrient loading washed into the river from fertilized agricultural land. The fertilizer wash-in problem should be watched carefully by the monitoring agencies as well as other agencies if conditions worsen. The Front Royal sewage treatment plant, put into operation in 1982, has reduced high organic loading and fecal coliform counts previously encountered downstream.

The Lord Fairfax Soil and Water Conservation District (LFSWCD) recommends control of non-point sources of nutrients by the Best Management Practices (BMPs) for agriculture such as: maintaining vegetated buffers or filter strips along rivers and tributaries, using grass swales for drainage in agricultural fields, containing animal wastes, and limiting and controlling fertilizer applications.

Map 3.6: Stream Drainage Basins

Section 6: Groundwater

Groundwater is an important drinking water source in Warren County. County leaders have been proactive over the past 20+ years studying the quantity and quality of groundwater in the County and protecting this important natural resource for the citizens.

Because of the problems outlined in four creditable publications: *Threats to Virginia's Groundwater; Mapping Groundwater Pollution Potential For Warren County, Virginia, 1988; Evaluating Household Water Quality in Warren County, Virginia, 1991; and Preliminary Groundwater Resource Evaluation of Warren County, 2001*, the County should explore state and local governments grant funding opportunities to continue to study groundwater contamination (**Map 3.7**). Due to Warren County's physical characteristics being similar to those of Clarke County, Warren County has adopted similar ordinances to protect groundwater. The generalized geology of Warren County is illustrated in **Map 3.8**. In 1991, the County adopted an ordinance for areas in the County located in the Catoctin Greenstone Geologic Formation due to the concern of groundwater contamination in these areas. The ordinance requires additional well and septic separation distances. In 2001, the Board of Supervisors adopted this ordinance Countywide after a study of the groundwater quality.

Expanding development and the prolonged drought from 1999-2002 focused attention on the quantity and sustainability of the groundwater resources in Warren County. A study was conducted between May 2002 and October 2008 by the USGS, in cooperation with Warren County, to describe the hydrogeology and groundwater availability of the metamorphic and siliciclastic fractured-rock aquifers in the county and to establish a long-term water monitoring network. The study area encompassed approximately 170 square miles of the county and included the metamorphic rocks of the Blue Ridge Physiographic Province and siliciclastic rocks of the Great Valley section of the Valley and Ridge Physiographic Province. Well depths were examined and the study found that groundwater flow systems in the county are extremely vulnerable to current meteorological conditions. Successive years of below-average effective recharge causes declines in water levels, spring discharges, and streamflows. Lack of precipitation, especially snow, during the critical recharge period (January—April) can have a substantial effect on the amount of recharge to the groundwater system and eventually on the stream base flow. This USGS groundwater study is on file in the County's Planning office.

Terrain through the County's most heavily developed areas has a great potential for groundwater contamination (**Map 3.7**). Improperly sited septic fields, storm water run-off, leaking underground storage tanks, leaking landfills, and dumping in sinkholes all contribute to the problem. There also is danger of flooding, habitat destruction, and land subsidence. As a result, all karst terrain should be considered sensitive to development. In the mid to late 1990's citizens of the Rockland area of Warren County raised concerns about the potential impacts that increasing industrial development along the Route 340/522 corridor northeast of Front Royal could have to groundwater quality. The Cedarville Enterprise Zone Karst Study was approved through the Division of Natural Heritage to the EPA and administered by DCR's Division of Soil and Water Conservation and began in 2000. The Cedarville Enterprise Zone area has been targeted for commercial and industrial development. The area however covers much of the recharge area for a cavernous limestone aquifer supplying water to numerous springs and wells. Such a landscape is described as karst. Karst landscapes are formed over geologic time by the dissolving of bedrock rather than by the erosional processes that characterize other landscapes. Features that characterize karst landscapes include sinkholes, sinking streams, caves, internal drainage, and large flow springs. Karst areas are very susceptible to groundwater

contamination, since a large proportion of surface drainage quickly enters the aquifer. The Cedarville Enterprise Zone Karst Study identified the karst features in this area. The study established stations for groundwater flow and water quality monitoring. It developed karst hydrology maps and a conceptual model for the Rockland / Enterprise zone area. During the course of the study, a population of the Madison Cave Isopod, listed as threatened under the US Endangered Species Act, was discovered beneath the Fishnet swale along the southeast margin of the enterprise zone near the Kelley Industrial Park. The study was completed in 2006 and a copy can be found in the County's Planning office. The study produced recommendations for Best Management Practices and stormwater management policies in karst areas, which the County has implemented with new developments in these areas.

Adequate domestic water supplies are obtained from 30-75 feet deep wells yielding 5 to 50 gallons per minute, with most wells yielding less than 20 gallons per minute. Larger yields may be obtained from deeper wells. Groundwater from the rocks in this area is often muddy or turbid, moderately hard, high in dissolved solids, and sometimes acidic. The mud and turbidity problems can usually be solved by proper well construction, but chemical treatment is often needed to control the other conditions. An exceptionally favorable location for drilling, according to available records, seems to be the southwestern part of the shale belt between the South Fork of the Shenandoah River and the Massanutten Mountains.

Wells in the central portion of the County (**Map 3.8**) average 250 to 350 feet in depth and yield from 10 to 70 gallons per minute. All wells recording yields of more than 60 gallons per minute were drilled in limestone to depths greater than 500 feet. Water from limestone and dolomite is low in dissolved solids, but usually is hard. Water from shale is moderately hard, but contains more dissolved solids and is frequently high in iron content. Most of the wells in the County's central and western sections are strong, although in the vicinity of the Cedarville area, the yield is less than average.

Wells are located in the narrow strip of sandstone and quartzite (**Map 3.8**) along the southwestern boundary of the County (Massanutten Mountains). The water is moderately hard and contains iron, but should be of good chemical quality.

Only small quantities of water are available in the County along the Blue Ridge mountains and its foothills (**Map 3.8**). Wells in this area average from 50 to 300 feet in depth and yield 1/4 to 20 gallons per minute. Half of the wells yield less than 5 gallons per minute. The deepest well is 650 feet and is the best producer. The groundwater's general chemical quality in this portion of the County is good.

In the County's southeastern area (**Map 3.8**), well records indicate that the pre-Cambrian rocks are fairly good sources of groundwater. Shallow wells are reported to yield moderate water quantities and to average about 15 gallons per minute.

Front Royal is Warren County's only community with a municipal water supply system. Its main source is the South Fork of the Shenandoah River. Small catchment impoundment's on Happy Creek, in the Harmony Hollow area, provide a secondary source. After undergoing sand bed filtration and chemical treatment, the water is distributed by gravity flow through a 96-mile network of water lines.

There are communities within the County that have central water systems. These subdivisions include: High Knob, Freezeland Manor, Shenandoah Shores, Shenandoah River Estates, Jackson's Meadow, and Dungadin.

Map 3.7 Groundwater Contamination

Section 7: Wetlands

There was a time, not too long ago, when wetlands (marshes, bogs, and mucky soils) were viewed solely as disease and pestilence sources. Early government involvement consisted of give-away programs with the condition that wetlands be drained and filled for useful purposes such as farming. In the 20th century, well-intentioned public and private efforts to provide flood protection, mosquito control, greater agricultural productivity, better highways, and many other societal benefits often have resulted in filling or draining wetlands for farming, forestry, industry, and development. A minimum 50 foot resource management buffer should be established around all Federally identified wetland areas.

In recent years, research has concluded that wetlands play a vital role in the environment. The National Wetlands Inventory prepared by the U.S. Dept. of Interior, is on file in the Warren County Planning and Zoning Office. Wetlands are valuable for the many physical, hydrological, biological, and cultural functions which they provide. These include:

Physical

- Wetland vegetation and shallow waters absorb and reduce bank erosion.
- Wetlands slow water velocities and reduce sediment in the water.
- Wetland plants and bottom sediments are sinks or collectors of excess nutrients such as nitrates and phosphorous.
- Wetlands trap waterborne heavy metals, herbicides, and pesticides.
- Wetland plants re-oxygenate water, thereby lowering biological oxygen demand.

Hydrological

- Wetlands act as floodways when associated with rivers and adjacent floodplains which convey water downstream.
- Wetlands store water during floods and release volumes slowly, reducing drastic flood surges.
- Wetlands, while most often are water discharge areas, also can act as groundwater recharge areas.

Biological

- Wetland plants and invertebrates are the basis of a highly productive food chain.
- Wetlands are nursery and spawning areas for many species of fish.
- Wetlands are also an important habitat for many waterfowl and wildlife species, serving as protective areas for feeding, resting, and breeding.

- Wetlands are habitat for many rare and endangered species. Almost 35% of protected animal species are found in wetlands, although wetlands cover only about 5% of the nation's land area.

Cultural

- Wetlands often contain important historical and archeological sites because they were early sources of food.
- Wetlands serve important recreational and commercial values for fishing, hunting, and trapping.
- Wetlands which are forested can be managed for valuable timber production.
- Wetlands provide scenic natural spaces and often serve as areas for bird and wildlife observation.

Section 8: Geology

The geology of a region involves studies of the physical, mineralogical, and chemical characteristics of the rocks and their stratigraphic relationships, structural attitude, and economic potential. Environmental geology may be defined as the application of geologic factors and principles to the problems created by human occupancy and use of the physical environment. To produce an overall long-range plan for the most efficient and beneficial use of the land, all environmental science factors must be considered.

Warren County is part of the northern Appalachian Valley, also known as the Shenandoah Valley because of its major river. The County's central and western sections are a part of the Valley and Ridge physiographic province. The County's eastern section is part of the Blue Ridge physiographic province. The Virginia Map (**Map 3.9**) shows Warren County's geologic relationship to the rest of Virginia. It is apparent that the geologic formations found in Warren County extend all the way from Maryland to Tennessee. This is important because the same geologic related problems in Clarke or Page Counties also are possible in Warren County since the bedrock and soils are the same.

The County's extreme southwestern portion, or the eastern ridge of the Massanutten Mountains, is underlain by quartzite and sandstone. The County's central portion has limestone, dolomite, and shale bedrock (**Map 3.8**). The eastern area, consisting of the Blue Ridge Mountains and its foothills, is comprised mainly of igneous and metamorphic rocks, including granite, greenstone, conglomerate, quartzite, etc. (**Map 3.8**).

The bedrock underlying Warren County's surface soils include a variety of sedimentary, metamorphic, and igneous rocks. These include limestones, dolomites, sandstone, shale, siltstone, conglomerate, quartzite, phyllite, tuff, granite, and other meta-sedimentary rocks. Soils found over these different rock types are the result of the underlying bedrock's weathering.

Present structural bedrock configuration has been caused by compressive forces from the east. These movements, over very long periods of time (millions of years), have resulted in bedrock that is broken, faulted, fractured, foliated, jointed, and in some cases, completely overturned. In addition, further action of natural forces such as rain, snow, ice, and groundwater, etc. form sinkholes, caves, channels, fissures have caused further bedrock deterioration. Land use decisions should be based on environmental geology data obtained from geologic characteristics such as lithology, slope stability, erodibility, sinkholes, cave areas, and rockfall areas. Geologic factors which affect Warren County's land use (**Table 3.1**) apply to the units shown on the Generalized Geology Map (**Map 3.8**). Rock structure and outcrop/sinkhole columns give general information about the soils and bedrock, including surface exposure and subsurface structure. Land use limitations range from severe to moderate with most of the County having severe to no on-site liquid and/or solid waste disposal (**Map 3.8**). Because of the geologic factors, both short and long-range plans must contain standards that correct existing environmental conditions, i.e. failed septic systems and contaminated groundwater. Geologic factors are also important to consider in controlling future development in the County.

Planning Implications: Mineral Resources

At numerous County locations limestone and dolomite long have been quarried for crushed stone and the manufacture of lime and rockwool. Currently, limestone and dolomite quarried at Riverton, are used for crushed stone and for masonry cement. High calcium limestone is found north of Riverton. Quartzite, excavated near Front Royal, is locally used as base and driveway stone. Iron, manganese, and copper ores have been mined in the past. Limestone, dolomite, sandstone, granite, and shale are available as raw materials for many purposes (**Map 3.10)**. Sand and gravel are also available in the County. Samples of shale have been tested and found potentially suitable for the manufacturing of brick, tile, and lightweight aggregate. Basalt and granite are possible construction stone sources.

Map 3.8 Generalized Geology

Map 3.9 Generalized Geology of Virginia

Map 3.10: Mineral Resources

Table 3.1 Geologic Factors Affecting Land Modification

Map Unit	Explanation	Rock Structure	Outcrops & Sinkholes	Limitations	Potential Use
1	Acid sandy soil underlain by sandstone and quartzite.	Bedding thick to massive; folded; joints widely spaced; well developed; closely spaced joints produce rectangular blocks.	Outcrops abundant on steep slopes, low to moderate slopes often covered with rectangular blocks in a sandy matrix.	Severe limitations for urban development and agricultural uses because of steep slopes and thin rocky soils.	Potentially good for woodland and recreational activities that require minimal construction and no on-site waste disposal.
2	Shaley soil overlying interbedded shale and sandstone.	Folded, many small displacement faults; steep southeast dipping cleavage; bedding thin to thick.	Outcrops abundant along valley sides.	Moderate to severe limitations for liquid and solid waste disposal due to shallow depth to bedrock; perched water table seasonal wetness locally; agricultural uses restricted by slope, thin soils, and seasonal wetness.	Fair to good for pasture and small grains; good potential for urban development not requiring on-site liquid waste disposal.
3	Variable residue soil thickness overlying limestone and dolomite.	Bedding thick to laminated; folded; southeast dipping cleavage.	Outcrops abundant along streams and locally in upland areas; large sinkholes common to abundant, small sinkholes abundant, karst terrain, cave openings common.	Moderate to severe limitations on urban development because of rock pinnacles, sinkholes, and high shrink-swell clays; severe limitations on liquid and solid waste disposal; agricultural uses subject to limitations of slope, rock outcrops, and high shrink-swell clays.	Agricultural potential generally good.

Table 3.1 Geologic Factors Affecting Land Modification (cont'd)

Map Unit	Explanation	Rock Structure	Outcrops & Sinkholes	Limitations	Potential Use
4	Marked changes in soil thickness occur over short distances; underlain by limestone, dolomite, shale, siltstone, and sandstone.	Bedding laminated to massive; folded; southeast dipping cleavage, jointing well developed, locally blocky.	Outcrops common to abundant along streams; small sinkholes common to abundant.	Moderate to severe limitations on urban development because of rock pinnacles, sinkholes, and high shrink-swell clays; severe limitations on liquid and solid waste disposal; agricultural uses subject to limitations of slope, rock outcrops, and high shrink-swell clays.	Agricultural potential generally good.
5	Acid sandy soil underlain by phyllite, sandstone, conglomerate, and subarkose.	Bedding massive in sandstone; phyllite foliated; folded; southeast dipping cleavage; sandstone and quartzite with well developed joints.	Outcrops abundant on steep slopes.	Severe limitations on urban development and agricultural uses because of steep slopes and thin rocky soils.	Potentially good for woodland and recreational activities that require minimal construction and no on site water disposal.
6	Variable depth residual soils underlain by greenstone, tuff, epidosite, and metasedimentary rocks.	Closely spaced jointing; southeast dipping cleavage.	Outcrops abundant on steep slopes.	Severe limitations on urban development and agriculture uses because of steep slopes and thin rocky soils; moderate limitations on low to moderate slopes.	Potential for urban development and agricultural uses good on low to moderate slopes in areas of non-skeletal soils.
7	Residual soils underlain by granitic rocks.	Massive; joints well developed; exfoilation, boulders common.	Outcrops common to abundant on steep slopes.	Severe limitations on urban development and agricultural uses because of steep slopes and thin rocky soils; moderate limitations on low to moderate slopes.	Potential for urban development, agricultural uses, and solid waste disposal, good on low to moderate slopes.

Planning Implication: Water

The fine classic sedimentary formations are consistent producers of small to moderate water yields from intermediate depths. The eight carbonate formations have a wide range of water-well depths and yields, while the two igneous formations commonly yield only small water quantities at relatively shallow depths. Several factors currently contribute to local groundwater supplies' degradation. These factors include discharge of untreated industrial waste water into the Shenandoah River by sewage disposal plants (including those outside of Warren County), very high incidence of septic-tank failures in many communities, and developments in the County. All County soil series have moderate or severe restrictions for septic tanks. Of particular concern are those areas of carbonate rocks as well as those of fractured and faulted rocks.

Section 9: Forest Resources

Trees provide lumber for our houses, fuel for our fireplaces, shade for our comfort, fruit for our tables, and beauty to enjoy. Collectively, they act as windbreaks, prevent erosion, filter the air, and provide oxygen. In spite of this, the general attitude is to destroy all, or most trees, as a first step in development. With due care for site design and its man-made amenities, a more attractive and valuable development will result, while retaining views and natural drainage patterns.

Ownership patterns and forest resource management are important when considering forested areas as biological habitat or for their value in protecting water quality. Forested areas provide habitat for numerous plant and wildlife species and also are an excellent filter for groundwater recharge. Forests also form an excellent windbreak in agricultural areas and serve to prevent windblown soil erosion. In addition, forested areas are an effective visual and noise buffer between land uses. Best management practices ensure the conservation of the County's extensive public and private forest resources.

A majority of Warren County land is well suited for forestry. The Soil Conservation Service has identified small portions in the eastern, western, and southern sections as being poorly suited for woodland. While much of Warren County has soil suitable for forestry, the largest forests exist in areas where the soil is least productive for forestry uses (**Map 3.11**).

Land in the County's central and eastern section is the most favorably suited for forestry. Soils in these areas have a high potential for growing both pine and hardwood species. The terrain ranges from nearly level to moderately steep. Natural wood lots consist of mixed stands of oak, locust, black walnut, ash, sycamore, hemlock, black locust, hickory, and yellow poplar.

Small areas in the County's extreme western, northeastern, and extreme southern sections are poorly suited for forestry. In these areas terrain ranges from sloping to very steep. Natural wood lots consist of mixed stands of oaks, pines, black locust, hickory, red maple, hemlock, and yellow poplar.

Map 3.11: Soil Suitable for Woodland

Section 10: Wildlife

The numbers and diversity of wildlife species present in an area are determined in part by the quantity and quality of wildlife habitat availability, especially food availability and protective cover.

The major threat to indigenous species in developing areas is the fracturing and fragmenting of habitat areas. When habitat is cleared for development or agriculture, not only is the cleared habitat area lost, but the habitat area also is degenerated at the development edge. This results in disturbance to interior habitat areas as well. Certain wildlife species require large, unfragmented habitat areas in order to survive. Wildlife also needs movement corridors from the Shenandoah Natural Park to related natural areas.

The Natural Heritage Program was established in 1986 in joint cooperation with the Nature Conservancy to identify elements of natural biological diversity which are of rare or special concern in Virginia. The program focuses on rare plants, animals, geological landmarks, natural ecological communities, and other natural features. The locations and characteristics of these natural features are entered into a computerized data base.

Endangered and threatened plant species are protected by the Virginia Department of Agriculture and Consumer Services, which uses information from the Natural Heritage Program inventory. Warren County needs to work cooperatively with these resources to assure the health of indigenous species.

Section 11: Greenways

Greenways are open, planted areas dedicated to parks, trails, buffer areas, and serve as connecting links between developed areas. Greenways help reduce development density, provide safe transition from highway to housing, and add value to property (tax base). Greenways along streams, help prevent erosion, filter chemical run-off, and help to slow and reduce damage from flooding. Greenways also help preserve biological diversity of plant and animal species by providing connections between areas of natural habitat. In addition, Greenways help keep development away from important natural resource areas while adding value and enhanced quality of life to the development. Where possible, the extension of the Greenways identified in the Town of Front Royal's plans should be extended into the County.

Section 12: Solid and Hazardous Waste Management

What makes hazardous waste hazardous? If it's IGNITABLE, CORROSIVE, REACTIVE, or TOXIC, it is HAZARDOUS. In Virginia, 81 facilities have permits to store, treat, or dispose of hazardous wastes. The Hazardous Waste Facilities Siting Act governs the siting of Virginia's hazardous waste facilities. The Virginia Department of Waste Management regulates 581 large quantity generators of hazardous waste, 1,374 small generators, and 319 transporters of hazardous wastes.

In Warren County solid and hazardous waste sites include landfills, open dumps, waste ponds and lagoons, household hazardous waste, agricultural manure, and commercial operations. Septic systems are the principal polluter of groundwater according to the U.S. Environmental Protection Agency. The contaminants include nitrates, coliform bacteria, viruses and a variety of organic and inorganic chemicals. Many of the septic systems in Warren County have been used for over 25 years and each year many of them fail and/or the soil's capacity to filter the impurities from the effluent has been exceeded. Many of the homes and businesses in the Town of Front Royal are still on septic systems.

There are two closed solid waste landfills located in Warren County. The Bentonville facility is currently used as a transfer station for solid waste that will be disposed of in the Page County landfill. An average of 1,935 tons of waste disposed of monthly. The storage area must be washed and the effluent trucked to the Front Royal sewage disposal facility. Only the Bentonville landfill is regularly monitored. The old Town and County landfill north of Rt. 619 is not being monitored.

Based on natural features, the only area that should be considered for major development and only if central sewage systems are available, lies between the Blue Ridge foothills on the east and the South Fork of the Shenandoah River and Route 340/522 on the west. This area, exclusive of the land reserved for the Agricultural District, represents approximately 22% of the County.

As the population and the number of industries within the Shenandoah River Basin increase, strict attention must be paid to the adequacy of existing waste treatment facilities. The Town should adequately plan for future water and sewer needs. Forecasted deficiencies would enable industries or Front Royal to provide supplemental equipment long before the capacity of installed facilities are exceeded. Each governing body should require industries to provide environmental impact studies that clearly state the pollution controls to be employed, the reliability of those controls, and the safeguards that will exist in the event of a primary control failure. Industries with significant environmental problems should be discouraged from locating in the County.

Section 13: Hazard Mitigation Planning

In 2000, the Disaster Mitigation Act of 2000 was signed into law. This law established a national pre-disaster hazard mitigation grant program that would help to reduce loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from natural disasters. The law requires local governments to prepare and adopt jurisdiction-wide hazard mitigation plans for disasters declared after November 1, 2004, as a condition of receiving Hazard Mitigation Grant Program project grants and other forms of non-emergency disaster assistance. Local governments must review and, if necessary, update the mitigation plan every five years from the original date of the plan to continue program eligibility. Mitigation is commonly defined as sustained

actions taken to reduce or eliminate long-term risk to people and property from hazards and the impacts of hazards. Hazard mitigation focuses attention and resources on community policies and actions that will produce successive benefits over time. A mitigation plan states the aspirations and specific courses of action that a community intends to follow to reduce their vulnerability and exposure to future hazard events. These plans are formulated through a systematic process centered on the participation of citizens, businesses, public officials, and other community stakeholders.

A local mitigation plan is the physical representation of a jurisdiction's commitment to reduce risks from natural hazards. In 2003, the State encouraged the planning districts to take the lead on development of local hazard mitigation plans. Our planning district, the Northern Shenandoah Valley Regional Commission led the process for developing a plan, working with the jurisdictions within the planning district to develop and adopt a multi-jurisdictional hazard mitigation plan. In 2006, the Warren County Board of Supervisors approved a resolution adopting the Northern Shenandoah Valley Multi-Jurisdictional Hazard Mitigation Plan. The Plan includes Warren County's hazard identification and risk assessment, capability assessment, mitigation strategies which include goals, objectives and a range of actions to achieve the County's goals. Warren County should continue to participate in local and regional hazard mitigation planning and continue to increase public awareness about local hazards and risks which will enable informed decision making on where to live, purchase property, or locate businesses. Although nothing can be done to prevent natural hazard events from occurring, by planning and preparing for these events, the region and Warren County is now poised to minimize the disruption and devastation that so often accompanies these disasters.

Section 14: Dam Break Inundation Zones

Dam Inundation Areas also called Dam Break Inundation Zones are the areas downstream of a dam that would be inundated or otherwise directly affected by the failure of a dam. These areas are subject to flooding due to topological and geographic patterns of the land during both dry "sunny day" dam breaks or storm related flood events.

All dams in Virginia are subject to the Dam Safety Act and Dam Safety regulations unless specifically excluded. It defines "impounding structures" or "dam" as a man-made structure, whether a dam across a watercourse or structure outside of a watercourse, used or to be used to retain or store waters or other materials.

On March 8, 2008 the Virginia State Assembly approved House Bill H837 establishing Dam Break Inundation Zone requirements. It requires that dam break inundation zones be determined by certified engineers contracted by the dam owners and shown on maps available to the general public.

Table 3.2 lists the twelve dams that have been inventoried in Warren County and one in Frederick County.

Table 3.2 Inventory of Dams Located in Warren County

Inventory#	Name of Dam - Owner	Constr. Date	Latitude ddm	Longitude ddm	Class	River/ Stream
06913	Lake Frederick Dam Wheatlands -VDGIF	1967	39 2.5	-78 9.5	I	Crooked Run
18701	Lake of the Clouds Dam- Shenandoah Farms POA	1962	38 59.4	-78 2.5	II	Venus Branch
18702	Lake John Dam	1962	38 58.9	-78 15.9	III	Molly Booth Run
18703	Spring Lake Dam	1968	38 59	-78 2	II	TR-Venus Branch
18704	Deer Lake - Blue Mountain Dam	1959	38 57.7	-78 2.6	III	TR- Howellsville Branch
18705	Lake Front Royal Dam	1970	38 52.6	-78 9.1	II	Sloan Creek
18706	Cooley Dam	1967	38 59	-78 13.3	III	Molly Camel Run
18707	Sullivan Dam	1966	38 52.6	-78 13.6	III	TR-Dry Run
18708	Warren "Hydropower" Dam	1924	38 57.3	-78 8.9	III	Shenandoah River
18709	Apple Mountain Lake Lower Dam	1973	38 55.8	-78 6.5	II	TR- Oregon Hollow
18711	Apple Mountain Lake Upper Dam	1973	38 55.7	-78 6.5	II	TR- Oregon Hollow
18712	Loch Linden Dam	1973	38 56.5	-78 5.6	II	TR- Oregon Hollow
18713	McCaffrey - Mountain Pond Dam		38 58.2	-78 18.1	II	N/A

Warren County is located in Dam Safety Region 1 as determined by Virginia Department of Conservation and Recreation.

Map 3.12 Development Constraints

Map 3.13 Dam Locations

Goals & Objectives

All County residents play an important role in maintaining Warren County's environmental system's balance. As the County grows, susceptibility to system imbalance and environmental damage increases. The amount of growth and development that Warren County can absorb without threatening environmental quality and resource supplies is limited. According to the concept of carrying capacity, Warren County is equipped with a finite supply of natural resources which can support a specified population. If this carrying capacity is exceeded, serious environmental degradation can occur and the solutions could be costly. Warren County probably will not reach its total County threshold for many years, but the influence of present activities has already been adversely experienced in certain areas.

Warren County's natural capacity is not fixed and can be improved significantly through protective environmental intervention. Given that Warren County is a complementary part of an environmentally balanced system, a re-examination of existing land use practices and activity patterns will indicate the necessary adjustments needed to increase the County's carrying capacity. Maintaining long-term growth options and significant economic advantages can be realized on a short-term basis; however, this requires decisions that are specific to individual sites.

The cost of resource reclamation is far greater than that of intervention and protection. If the consequences of environmentally damaging activities are left unbridled, the loss of resources must be accepted or taxpayers must bear the cost of addressing the problem. As an example, federal, state, and local tax dollars are being spent to correct environmental damage to the Shenandoah River which has resulted from decades of neglect and abuse. Current legislation and efforts to protect water quality will yield long-term dividends concerning this important environmental and economic resource.

Goal: To preserve and improve the environmental quality of Warren County through measures which protect natural resources and environmentally sensitive air, lands, and waters.

Objectives:

A. Institute measures to protect the quality of surface waters within the County, including the Shenandoah River's North and South forks, creeks, runs, dams, and smaller tributaries, as well as watershed and associated tributaries which eventually drain into the environmentally sensitive Potomac River and the Chesapeake Bay.

B. Protect and conserve fragile groundwater resources within the County's unique hydrology (i.e. karst terrain and thin soils), including the specific recommendations from the County's Cedarville Enterprise Zone Karst Study and the USGS Hydrogeology and Groundwater Availability Study.

C. Evaluate existing problems relating to failing septic systems and well water contamination.

D. Require regular septic pumpout using State recommendations/ guidelines.

E. Protect County wetland resources, including springs, from contamination.

F. Protect and conserve public and private forest resources to prevent soil erosion and damage to views, vistas, and watershed areas.

G. Protect the important natural function of rivers, streams, and floodplains by encouraging appropriate use and preservation of natural vegetation.

H. Minimize runoff and sedimentation associated with agricultural and development activities (including industrial, residential, and commercial activities) particularly in steep slope areas.

I. Identify and protect important plant and wildlife habitats, including aquatic life.

J. Require annual maintenance of alternative septic systems.

K. Coordinate environmental quality protection efforts with the establishment of public parks, natural recreation areas, and natural resource regeneration and preservation.

L. Improve environmental quality on a site-by-site basis through the establishment of performance standards for environmentally sensitive areas, including encouraging the use of best management practices.

M. Educate Warren County residents about the relationship between our land use decisions and our local ecology.

N. Preserve Warren County's natural beauty, while making natural features accessible to County residents.

O. Continue to use green concepts in the building of County facilities to further reduce our footprint on the environment.

Implementation

Adequate Public Facilities Standards - Maintain a LOS policy in conjunction with the County's Fiscal Impact Model. LOS policies provide the basis and criteria on which to evaluate alternatives and to determine capital requirements. LOS policies make a clear statement to developers and help reflect the public's expectations for County services. Maintaining LOS policies and standards for public services, would ensure that sufficient services were in place or would be provided as development occurs. LOS standards can ensure that service expansion coincides with new development.

Agriculture - Protect and enhance prime agricultural soils from development and encourage marketing of local produce.

Best Management Practices - Encourage the best recognized soil and water conservation management practices. This would include pollution control, with particular attention to groundwater contamination for all agricultural, forestry, and development areas, including parking lot runoff. Individual development sites and projects should be evaluated in accordance with the County Comprehensive Plan, Performance Standards, and Zoning Overlay Districts.

Capital Improvements Program (CIP) - Maintaining a CIP is important in meeting future needs.

Citizen Participation - Include County residents on committees and advisory Boards that provide additional input and comment to the Planning Commission and/or Board of Supervisors.

Coordination With Other Agencies - The increased pressure on animal habitats in the National Park and in the County makes it essential that greenways and travel corridors, in cooperation with the National Park and the National Forest, be established in appropriate areas. This would help increase the area's animal carrying capacity which is so important to tourists, conservationists, and hunters.

Directed Development - Direct future County development to designated districts where public sewer services are in place or are planned. Limit the future use of on-site sewage treatment systems to those areas where public sewage systems are unavailable. Discourage large concentrations of individual on-site sewage treatment facilities in rural and environmentally sensitive areas.

Encourage Adopt-A-River, Adopt-A-Road and Adopt-A-Spot - Encourage beautification programs which would involve and encourage local citizens to respect and preserve the environment.

Encourage Open Space – Encourage local citizens to preserve open space by placing their property in scenic easements with VOF, VCC, or the County. Encourage programs that foster preservation and assist farmers, such as agricultural/forestal districts.

Environmental Impact Statement - Enforce the County Zoning Ordinance (Section 180-64 A [1]), provision that requires the preparation and presentation of an Environmental Impact Statement by all proposed developers which identifies potential environmental problems and suggests appropriate mitigation strategies.

Extend bike and hiking paths – Cooperate with the Town of Front Royal to extend Front Royal's biking and hiking paths into the County, along the south fork of the Shenandoah River and along Routes 55 E., 340 S. and 522 S. Such paths and greenways should lead visitors into areas which would expose them to the year round beauty of our mountains, the bursting forth of life in the spring, and the riot of fall color.

Floodway Development Prohibition - Prohibit development within river and stream floodways. Encourage the use of floodway areas for recreational uses, agriculture, non-structural uses, and natural space. Adopt appropriate measures to protect floodway water resources from agricultural contamination. Also, prohibit the building of storage sheds, pit privies, or septic systems, in the flood zone.

Limit Future Development - Enact zoning provisions which would limit the types and intensities of development permitted in designated conservation and development districts and such environmentally fragile areas such as karst terrain, steep slopes, and floodplains. Particularly sensitive areas should be limited to low density residential uses, and park and recreation uses.

Natural Space Requirements - Establish natural space requirements and limit the extent to which a site can be covered by impervious surfaces. Requirements should specify minimum areas that must remain undisturbed and available for storm water infiltration and site vegetation. There should be maximum retention of natural vegetation and trees related to open spaces, with site clear-cutting expressly prohibited. A minimum resource protection buffer of 50-feet must be required along areas of karst terrain, wetlands, perennial rivers, and streams.

No-Net-Change - Continue to prevent no-net-change in runoff at development sites. Drainage techniques normally channel storm water runoff away from the structure and off of the site. The volume, velocity, and sediment content of storm water runoff leaving a developed site should be no greater than pre-development levels. Use Best Management Practices to limit discharge of oil, gas, etc. from parking lots and garages. Special requirements are needed when development occurs in areas such as karst terrain, where storm water directly enters the groundwater through depressions, sinkholes, and fractures.

Performance Standards - Incorporate into zoning and subdivision ordinances new performance standards for environmental protection within sensitive areas which would protect natural features and identify potential hazards such as wetlands, critical plant and wildlife habitat, karst terrain, floodplains, and slopes subject to erosion. Such standards would allow quantification of existing and potential problems and would define performance criteria in excess of minimum property standards applicable to less sensitive areas.

Note: When standards for new work, or an existing problem has been identified, a performance standard is chosen or developed that will assure the desired result. A desirable rather than a minimal standard is applied. In some cases the two can be the same.

Permit Evidence - Require evidence of all federal, state, and local environmental and health permits as a condition for development approval, thereby assuring that potential air, water, and soil contamination is addressed.

Preserve Natural Vegetation - Expressly prohibit site clear-cutting, thereby preserving natural vegetation and trees during development. Require the protection of mature trees and vegetation preservation during development. If tree removal is unavoidable, require replacement plantings. Encourage generally-accepted good forest management practices when private logging operations are anticipated. Where vegetation is removed, require grass seeding for erosion control.

Public Education and Participation - Encourage the incorporation of environmental concept curriculum in Warren County Schools and in civic associations.

Recreation - Provide varied access to natural features through means such as biking and hiking paths and public access to the Shenandoah River and tying into existing bike paths. This will allow residents and visitors to enjoy the County's recreational opportunities.

Recycling and Education - Maintain the recycling program and continue the County's twice a year cleanup days. Promote recycling through educational programs in local schools and civic associations.

Slope Density Regulation – Investigate controlling development, including building permits, in areas where the site slope could pose an environmental danger. Enact slope density regulations.

Views/Vistas, Tourism, and Rural Character - To preserve views from the Skyline Drive and vistas along County roads, both vital to tourism and rural character, discourage clear cutting and unnecessary tree cover and other natural vegetation reduction by application of best management practices. Encourage cluster development and discourage strip development.

Voluntary Proffers - Maintain a proffer system associated with the Capital Improvements Plan.

Zoning Related Incentives - Develop zoning criteria that will encourage cluster development while discouraging both residential and commercial strip development. Priority consideration should be given to cluster housing development with the minimum number of outlets to state and County roads, with broad tree and greenway buffers between the structures and public roads.

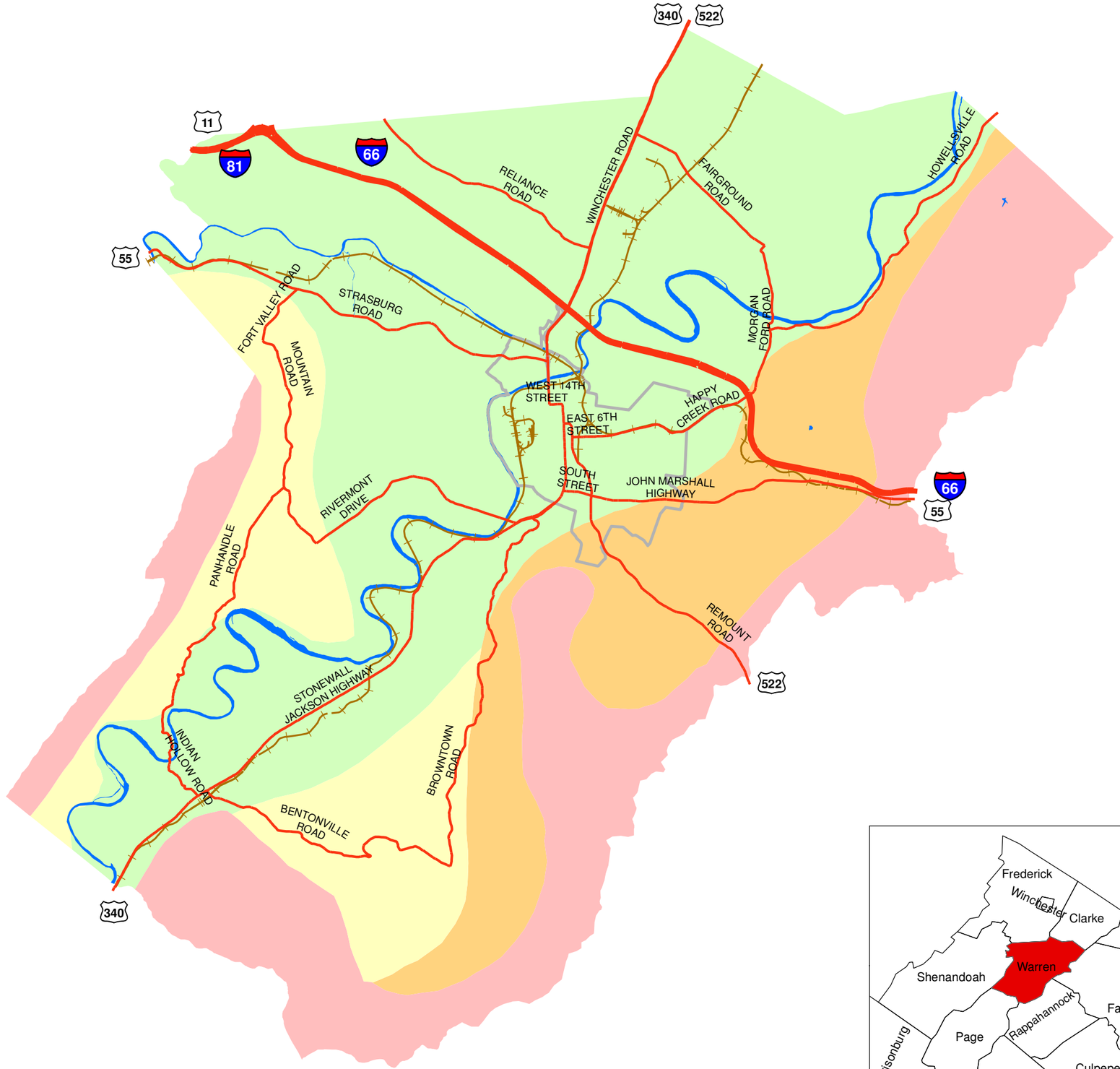
Chapter Summary

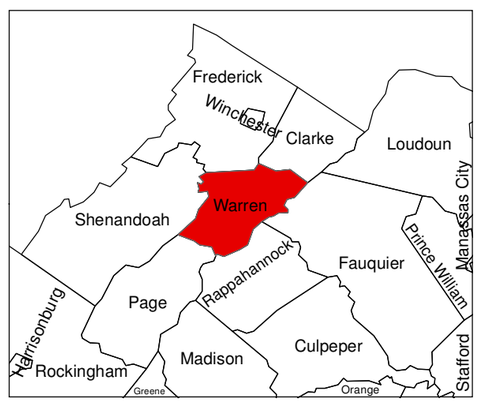
This chapter discusses the characteristics of the County's air, land, and water. It describes some of the important reasons for protecting the natural features which contribute to Warren County's environmental quality. Goals and objectives are identified for preserving environmental quality. The recommendations should achieve the County's goals and objectives.

In summary, Warren County's environmental attributes strongly influence the area's quality of life. The environment must be evaluated in terms of the potential impact upon the community's daily activities and standard of living. Environmental resources should be protected for both individual property interests and collective taxpayer investments. Warren County's environmental quality is one of the factors which makes the area such a desirable place to live and work. The intent of County environmental protection measures is not to stop development, but rather, to manage development, thereby ensuring development compatibility with the continued productivity and environmental protection of air, land, and water.

Warren County, Virginia

Map 3.2: Generalized Slope





Legend

- Interstates
- Major Roads
- Railroads
- Front Royal
- Shenandoah River

Slope Percent

- 0% - 7%
- 7% - 15%
- 15% - 25%
- 25% - 45%

N
W E
S

Miles
2 1 0 2

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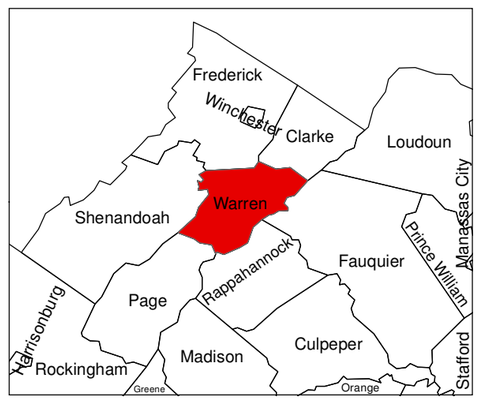
Warren County, Virginia

Map 3.3: Soils Suitability for Septic Systems



Legend

- Interstates
- Major Roads
- Railroads
- Front Royal
- Shenandoah River

Septic Suitability

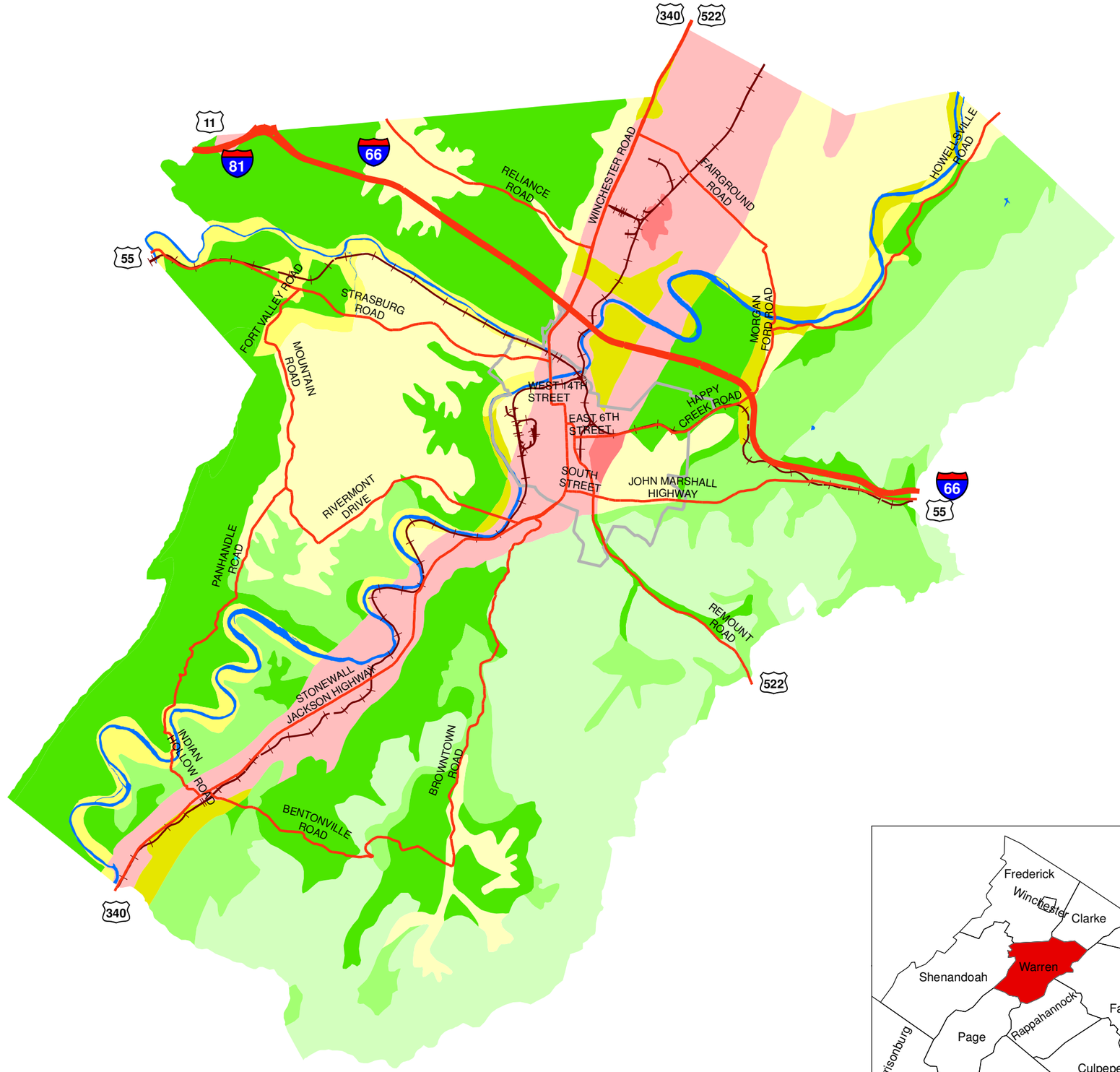
- Well Suited
- Suited
- Poorly Suited
- Unsuited

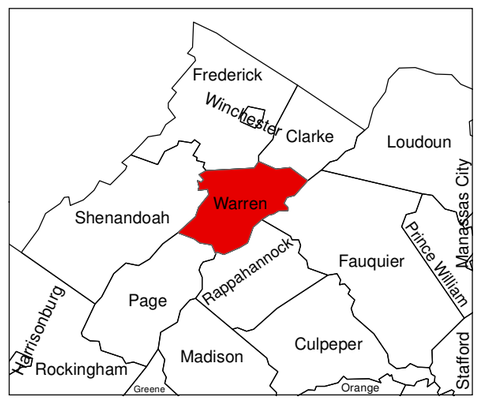
N
W E
S

Miles
2 1 0 2

Warren County, Virginia

Map 3.7: Groundwater Pollution Potential





Legend

- Interstates
- Major Roads
- Railroads
- Front Royal
- Shenandoah River

Drastic Index Range

- 79 & Below
- 80-99
- 100-119
- 120-139
- 140-159
- 160-179
- 180-199
- 200+

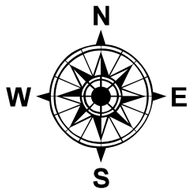
Source: Virginia Water Project, 1988

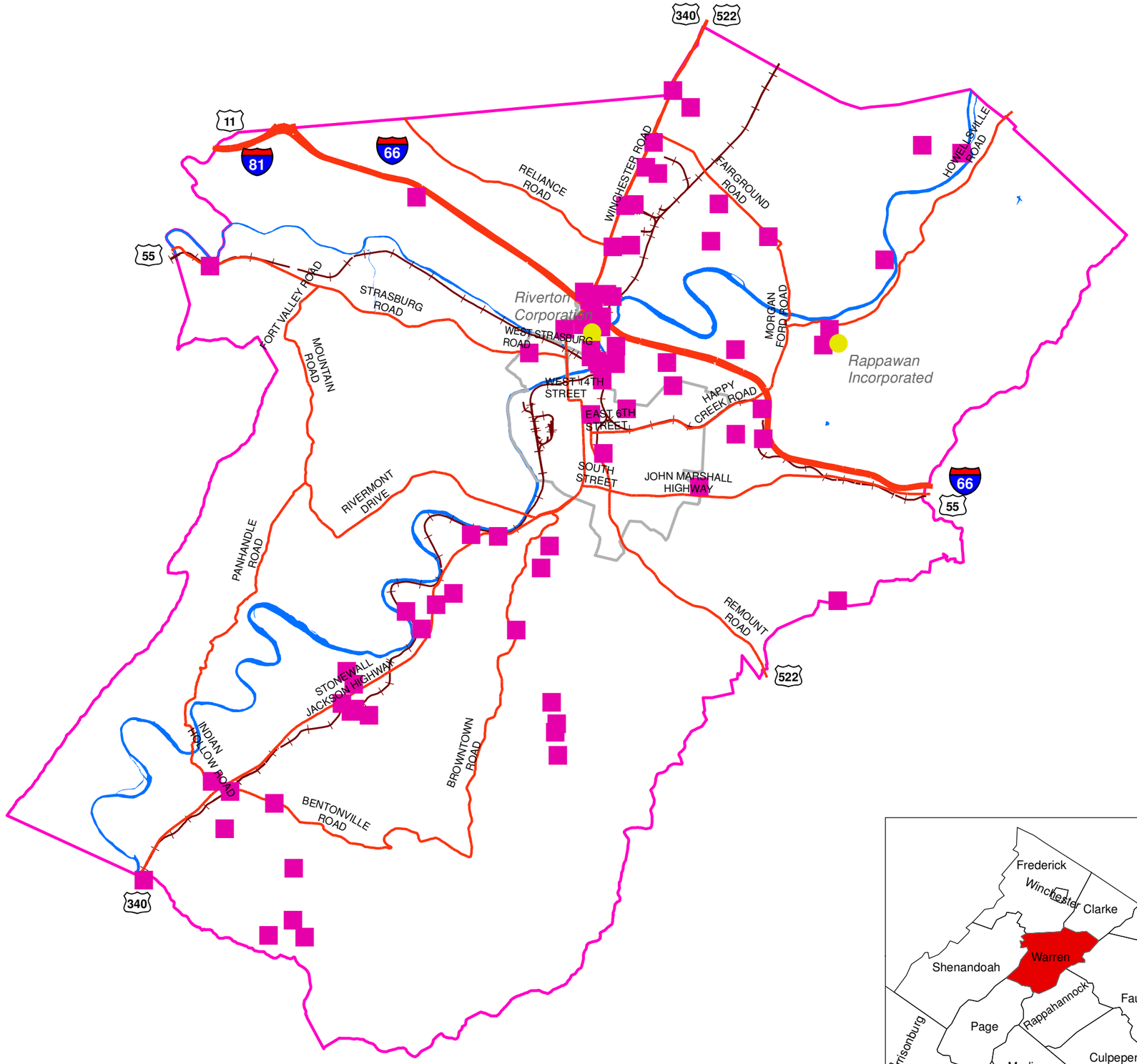
Miles

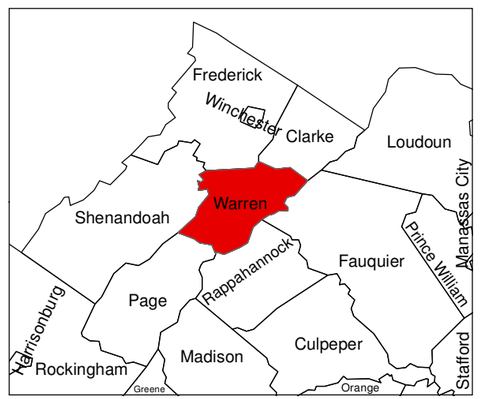
2 1 0 2

Warren County, Virginia

Map 3.10: Mineral Resources







Legend

Mineral Resource Locations

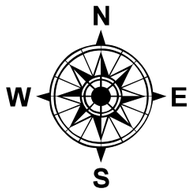
- Currently Active Site
- Inactive Site or Potential Resourse
- Interstates
- Major Roads
- Railroads
- Front Royal
- Shenandoah River

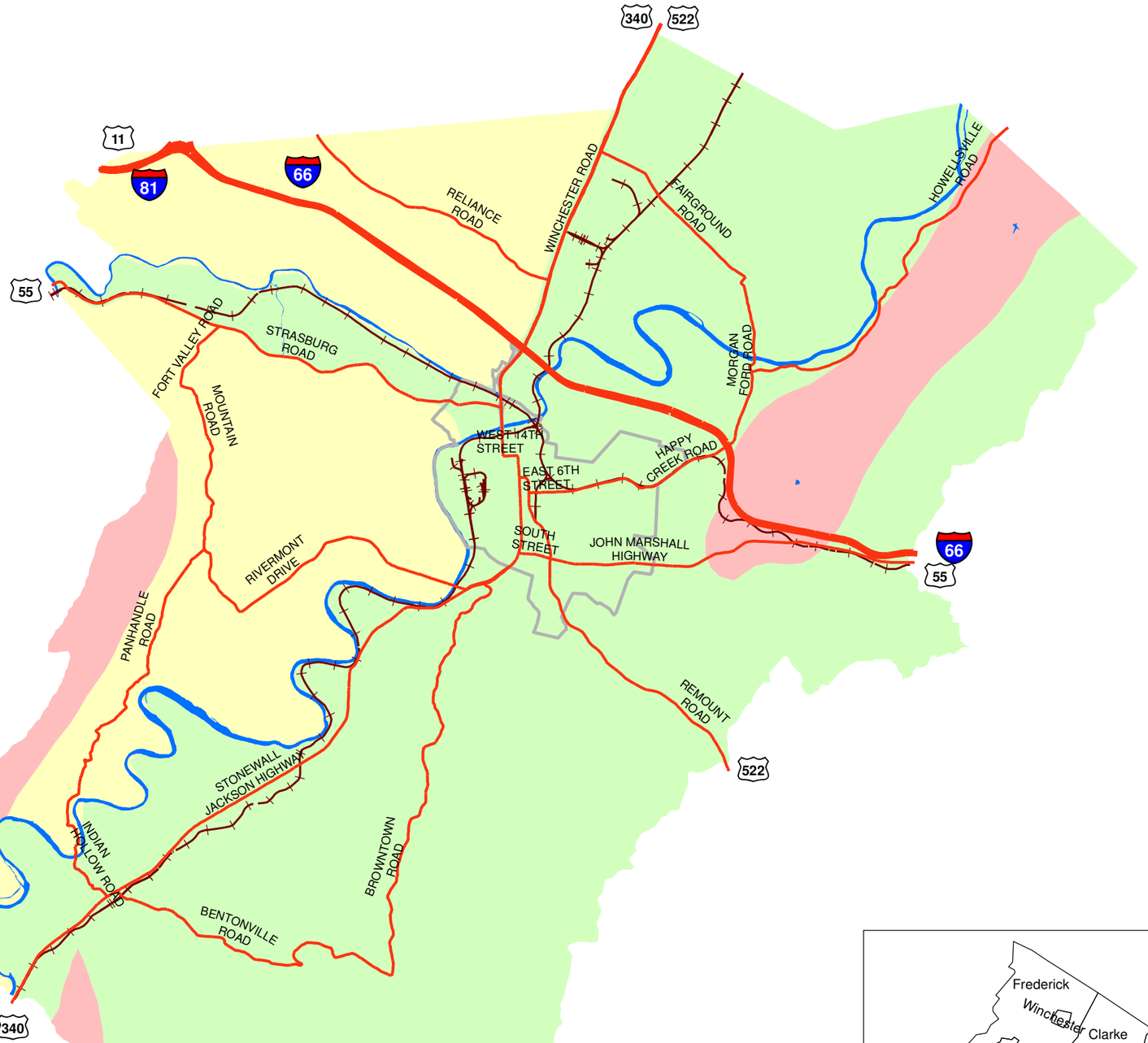
Miles

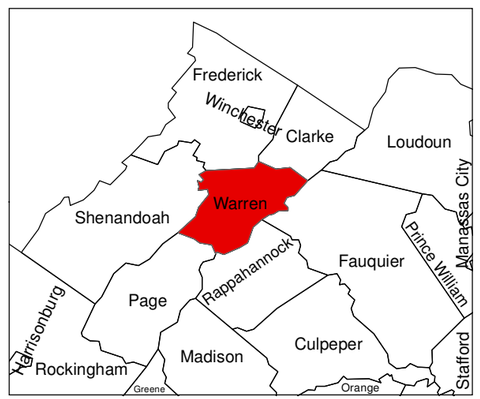
2 1 0 2

Warren County, Virginia

Map 3.11: Soil Suitable for Woodland







Legend

- Interstates
- Major Roads
- Railroads
- Front Royal
- Shenandoah River

Woodland Suitability

- Well Suited
- Suited
- Unsuited

Source: Soil and Water Resource Inventory, Warren County, 1971.

Miles

2 1 0 2