PLANNING TO PROTECT THE UPPER ETOWAH REGION: USING A BUILD-OUT ANALYSIS APPROACH TO TEST THE ENVIRONMENTAL AND ECONOMIC IMPACTS OF MULTIPLE REGIONAL LAND USE PLANS

by

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(Under the Direction of Laurie Fowler)

ABSTRACT

Three future development pattern scenarios of the Upper Etowah Region were created representing a continuum from sprawl to smart growth. A GIS was used to measure the impacts on stream health and rural land covers from the build-out of each scenario. A literature review was also conducted to assess any differences in public costs expected from the build-out of these scenarios. The smart growth scenario that directs development into mixed-use, clustered neighborhoods was found to be more protective of stream health and rural land. This scenario is also expected to result in more compact service delivery systems and thus, less public costs. The legal and market hurdles to implementing this smart growth scenario are discussed.

INDEX WORDS: Sprawl, Smart growth, Regional planning, Build-out, Land use planning, Watershed-based zoning, Township, New Urbanism, Mixed-use, Development pattern, Clustered development, Compact development, Downzoning, Overlay zone, Environmental planning criteria, Natural area, GIS, Cost of community services, Service delivery system, Etowah

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B.S., Berry College, 1997

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2003

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August 2003

ACKNOWLEDGEMENTS

This research was only possible through the assistance, support and spirit of many great people, and a dog. Laurie Fowler provided excellent constructive criticism throughout the completion of this document. Unbeknownst to me, she even postponed a trip to Costa Rica to help me meet a deadline for this thesis. She is a remarkably giving woman. Mary Freeman and Liz Framer also provided excellent input throughout the researching and writing of this thesis.

This research required a great deal of GIS modeling and data manipulation. Without the assistance of Bill Bumback, Jason Lee, Matt Elliot, Jeanne Epstein, Rich Kosvanec and Kevin Samples this research would have stalled in its formative stages.

Beth Gavrilles' passion for smart growth, commitment to a sustainable lifestyle and work with the Athen's Grow Green Coalition was an inspiration for this research. Seth Wenger's and Nanette Nelson's research on stream buffers and the cost of community services was relied upon throughout this document. They set the bar in terms of applied research integrity. Raysun Goergen's Upper Etowah Regional Greenspace Plan paved the way for this study.

Finally, I would not have survived this study if Emily Patterson and Sneed (my dog) had not provided the true friendship and loving support they did. Emily's pure, selfless spirit neutralized the irritability and frustration that this thesis provided. Sneed made me laugh, kept me grounded and was always happy to see me.

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CHAPTER 1

INTRODUCTION

Purpose of Study

Local governments in rapidly suburbanizing areas make policy and planning decisions that have long-term, widespread effects. The type, location and extent of land use zones, the permitted housing densities within these zones, and the scale of the transportation infrastructure that serve these land uses will greatly affect the distinguishing characteristics of these areas. These decisions commonly have to be made without a clear understanding of their consequences. Studies that compare the environmental and economic impacts of alternative build-out scenarios can simplify these decisions by revealing their consequences and reducing uncertainty.

The purpose of this study is to project the impacts of various future build-out scenarios on the aquatic, economic and rural character of the Upper Etowah Region. A future build-out scenario is the future development intensity and pattern of a landscape, such as a watershed or combination of counties (Theobald and Hobbs, 2002). Assessing the impacts of various future build-out scenarios will help inform elected officials and planning staff on the consequences of their land use decisions.

Several rapidly developing landscapes have been analyzed using a multiple build-out scenario approach, including Monroe County, Pennsylvania (Steinitz et al., 1994), Summit County, Colorado (Theobald and Hobbs, 2002), Camp Pendleton, California (Steinitz et al., 1996), and the Willamette River Basin, Oregon (Hulse et al., 2002).

These studies modeled a build-out scenario that was 20-50 years into the future. A 15-20 year forecast was used for the Upper Etowah Region study because the Planned Build-out Scenario is based on the participating counties' future land use plans. These plans forecast demographics, economic development, housing and infrastructure (roads, sewer lines, etc.) for each county at a 15-20 year interval. Study periods longer than 20 years into the future are also subject to progressively higher degrees of uncertainty (Steinitz et al., 2003).

Communities choose to grow in a variety of ways. One form is sprawl. Sprawl is defined by a landscape where: 1) population is widely dispersed in low-density housing; 2) shopping, housing and workplaces are rigidly separated; 3) a network of roads are characterized by limited access; 4) and well-defined activity centers such as downtowns and town centers are lacking (Smart Growth America, 2002). Sprawl-type development threatens biodiversity (Liu et al., 2003) and reduces the distribution of wildlife habitat (Terris, 1999), aggravates the effects of drought and increases non-point sources of pollution (American Rivers, the Natural Resources Defense Council, and Smart Growth America, 2002).

Alternatively, smart growth is a development pattern that preserves critical cultural, recreational, and agricultural greenspace and environmental areas by combining mixed-use developments with compact design in areas that are more suitable for development (O'Neill, 2000). The build-out of landscapes where growth is managed by these principles may be more environmentally and fiscally sustainable. In this study, build-out scenarios that incorporate smart growth principles are compared with sprawl-type build-out scenarios to assist local governments in the Upper Etowah Region in determining the environmental and fiscal consequences of their land use planning decisions.

Geographical Description of the Upper Etowah Region

The 1,414-mi^2 Upper Etowah Region is located in north Georgia. The five counties that form this region are Cherokee, Forsyth, Dawson, Pickens, and Lumpkin. Although the Etowah basin comprises only a portion of these five counties, in this study, the Upper Etowah Region is considered the entirety of each of the five counties. Most of the land use planning completed within this region focuses on individual counties rather than watersheds. Therefore, the full extent of each county was included in this study to ensure compatibility with existing planning endeavors. Figure 1 shows the five counties and major municipalities that compose the Upper Etowah Region.

The Etowah river begins in the Blue Ridge Mountains, north of Dahlonega and flows approximately 90 miles to Lake Allatoona, an Army Corps of Engineers reservoir constructed in 1949. The 725-mi^2 upper Etowah River subbasin contains only a fraction of the entire Etowah basin, which spans from Dahlonega to Rome, Georgia and encompasses 1,858 mi^2 of land (Coosa River Basin Management Plan, 1998). The Etowah River merges with the Oostanala in Rome to form the Coosa River. The Coosa River flows through Alabama and becomes the Alabama River before discharging into Mobile Bay and the Gulf of Mexico.

Ecological Status of the Upper Etowah Region

The Upper Etowah Region comprises a variety of land uses. The southern end of the region began developing rapidly in the 1970s as suburbs to the City of Atlanta. Today, approximately 7% of the region is composed of urban or suburban land, most of which is located in Cherokee and Forsyth counties. The remainder of the region is primarily composed of forest (77%) and agriculture land (9%) (Natural Resource Spatial Analysis Laboratory, 1998).

Ecologically, the most notable element of this region is the wealth of aquatic biodiversity located in the upper Etowah subbasin. Approximately 91 native species of fish inhabit or formerly inhabited the Etowah River. Fifteen of these species are believed to be extirpated from the system (Burkhead et al., 1997). Nine of the remaining species are imperiled. Of these, four species are thought to be endemic, including the Cherokee and Etowah darters and two undescribed cryptic holiday darter species. Five other imperiled fish species, including the amber darter, freckled darter, bridled darter, an undescribed species of speckled chub, and the "Coosa" madtom (also undescribed) are known to occur in the Etowah basin (Burkhead et al., 1997; Freeman, personal comment). Because this basin is renowned for its aquatic biodiversity, it has been recognized by The Nature Conservancy as a conservation priority and the United States Fish and Wildlife Service as a candidate for Habitat Conservation Planning.

Threats to Stream Health

The majority of threats to the natural environment of the Upper Etowah Region stem from the suburbanization of land (The Nature Conservancy, 2002). Specifically, the replacement of forest cover and soil by impervious surfaces changes the hydrology and chemical composition of surface waters. Non-point source pollution contributes to the sedimentation and alteration of the natural flow regime of the streams located here. Although these effects are common in areas that are rapidly suburbanizing, the imperiled fauna that are located here are habitat specialists that require moderate to swift currents over gravel or cobble substrates (Georgia Department of Natural Resources, 1999) and are not able to withstand these in-stream modifications.

The Upper Etowah Region is also experiencing suburban growth at a pace that far exceeds average. In fact, this is one of the fastest growing regions in the country. In 1999, the United States Census found that Forsyth County was *the* fastest growing county in the nation (U.S. Census Bureau, 1999). The Atlanta metropolitan area also added more new residents during the 1990s than any other metropolitan area in the United States, except for Los Angeles (Lockard, 2000).

This rapid growth rate is expected to continue. Based upon the comparison of population data from the 2000 Census (U.S. Census Bureau, 2003) and the population projections from the five Upper Etowah Region counties' respective comprehensive land use plans, total population is expected to double (300,308 to 622,793) in these counties by 2015. The vulnerability of the fish community located here coupled with the rapid suburbanization of this subbasin pose the greatest risk to the aquatic ecology of the Upper Etowah Region.

Threats to Rural Character

The rural character of the Upper Etowah Region has and continues to change. The southern end of the region is characterized by scattered suburban and commercial development. While Canton, Cumming and Woodstock have become viable economic development centers, their surrounding landscapes have become low-density suburbs. These suburbs also provide housing for Atlanta commuters. In fact, more than 25% of the residents of Cherokee, Forsyth and Dawson Counties commute to Atlanta for employment (Atlanta Journal-Constitution, 2003). The landscape around Lake Lanier has also become highly developed. Much of this area is exurban, second home development.

Although suburban and exurban development migrate north from Atlanta, Lake Lanier and the cities of Canton, Cumming and Woodstock, the majority of the Upper Etowah Region is characterized by rural residential development, rolling forested hills, chicken farms and small towns. In fact, outside of Cherokee and Forsyth Counties, only the Dahlonega and Jasper areas have a percent total impervious area above 10%. The remainder of Pickens, Dawson and Lumpkin counties are over 90% forested or in agriculture land use (Natural Resource Spatial Analysis Laboratory, 1998). Undoubtedly, the respite that the lush hills and pastoral quality provides this region both endears and endangers its long-term rural character.

Threats to Local Governmental Budgets

Although rural local governments often welcome suburban and commercial development for their perceived economic benefits, these developments come at a price. The police powers granted to these governments by the state require them to fund the community services required by these business and residential areas. New schools, roads, and utility lines are generally the most expensive growth accoutrements (Benfield, et al., 2001).

Local governments in the rural area of this region may not have general funds to provide these services. In fact, Pickens and Dawson counties have no long-range strategy to finance the construction of water, sewer or transportation infrastructure (Cook, personal comment; Vanden Bosch personal comment (a)). Although economic development is vital to the rural area of this region, the development must be planned responsibly in order to be fiscally sustainable.

CHAPTER 2

BUILD-OUT SCENARIOS

Three build-out scenarios were created for analysis. The Planned and Alternative I Scenarios have more of a sprawl-like pattern and are defined by the separation of land uses and the predominance of land classified for residential development. The Alternative II Scenario departs from this matrix and orients development into medium density townships. Since these townships provide the bulk of the housing in this scenario, the majority of the landscape is maintained as open space.

Planned Build-out Scenario

The Planned Scenario assumes that the build-out of the Upper Etowah Region will be identical to each county's future land use map coupled with the land use restrictions imposed by the Georgia Planning Act of 1989. Future land use maps are part of the land use element of each county's comprehensive land use plan. The restrictions imposed by the Georgia Planning Act are the rules for environmental planning criteria or minimum planning standards to protect the state's interest, such as drinking water. These rules include environmental planning criteria to protect water supply watersheds, groundwater recharge areas, wetlands, river corridors and mountains. Future land use maps that include the protected land established in the state’s rules for environmental planning criteria are the best available indicator of the projected build-out of the Upper Etowah Region. Figure 2 illustrates this map.

Georgia Planning Act Requirements

The Georgia Constitution (Article 9, Section 2) grants local governments home rule, or the power to adopt reasonable ordinances, resolutions, or regulations relating to its property and affairs. The significance of the Georgia Planning Act is that it provides a constitutionally sound methodology for regional cooperation and planning while maintaining home rule. State planning is therefore achieved through a bottom-up process. The Georgia Planning Act accomplishes this by requiring local governments to submit a comprehensive land use plan to the corresponding regional development center. The center then reviews these plans and notifies the remaining counties and municipalities within the region of the receipt of the comprehensive plan. A 60-90 day public comment period ensues before the plan and any modifications are officially approved by the regional development center (O.C.G.A. 50-8-37). A regional comprehensive plan is then formed from these individual plans and updated annually, with a comprehensive update completed every ten years (Sparks, personal comment).

The Department of Community Affairs accepts regional and local comprehensive land use plans submitted by qualified local governments and regional development centers. Along with the Governor, this department develops a comprehensive land use plan for the state (O.C.G.A. 50-8-7.1). The Department of Community Affairs enforces the Georgia Planning Act by establishing minimum planning criteria that must be met in order to receive qualified local government status. This status is required to be eligible for the various financial assistance programs that the state oversees, including recreation, historic and greenspace grants, and redevelopment and downtown revolving funds, among others (Georgia Department of Community Affairs, 2001). The withdrawal of funding eligibility is the only power the state has to enforce the completion of comprehensive land use plans.

Six topical planning elements are required of all local comprehensive plans under the Rules of the Georgia Department of Community Affairs (Chapter 110-3-2). These include 1) population, 2) economic development, 3) natural and historic resources, 4) community facilities and services, 5) housing and 6) land use. The land use element of a comprehensive plan consists of an existing land use map and assessment as well as a future land use map and narrative. Each element of the comprehensive land use plan must be updated within ten years in order to maintain qualified local government status. In addition, some local governments have elected to prepare 5-year short-term work programs or progress reports that outlines the local government's accomplishments in plan implementation since the completion of their previous update. These programs are completed at the local government's discretion, but do not replace an official comprehensive land use plan update.

Environmental Planning Criteria

In addition to requiring the preparation of comprehensive land use plans, the Georgia Planning Act (12-2-8) imposes minimum environmental planning criteria established by The Georgia Department of Natural Resources (Chapter 391-3-16) upon local governments. These criteria establish guidelines for development within water supply watersheds, groundwater recharge areas, wetlands, river corridors and mountain areas. Only the water supply watersheds criteria establish no-build zones, or areas where development is prohibited. Criteria for river corridor protection significantly limit the density of residential development allowed and prohibit all other forms of land development. Because these guidelines highly regulate the type and density of development permitted in river corridor and water supply watersheds, these criteria are accounted for in the Planned Scenario. The guidelines for groundwater recharge areas, wetlands and mountain areas focus primarily on prohibiting the disposal of solid and hazardous waste, not on development type and density. Therefore, these guidelines are not accounted for in the Planned Scenario.

The purpose in adopting environmental planning criteria for water supply watersheds is the state's interest in the protection of drinking water. A water supply watershed is defined as the land area upstream of a governmentally owned public drinking water intake. Minimum criteria vary depending upon whether or not the watershed is considered large (≥100 square miles) or small (<100 square miles). Impervious surface is prohibited within 150 feet of perennial streams that are located within a 7-mile radius of both large and small water supply reservoir boundaries.

Small water supply watersheds produce river flows of smaller volume and thus less pollution dilution capacity. Therefore, the state has imposed additional standards for these watersheds, namely a 75-foot impervious surface setback on all perennial streams within the watershed. Intermittent and ephemeral streams are not protected under the planning criteria for large or small water supply watersheds.

An average flow ≥400 cubic feet per second is required for a river to be protected under the criteria for river corridor protection under the environmental planning criteria. In the Upper Etowah Region, this criterion only applies to the Etowah River between the confluence with Shoal Creek, in Dawson County and Lake Allatoona. A river corridor is defined as the area located within 100 feet of the river, measured horizontally from the riverbank. Development is restricted to one house per two acres within the river corridor.

<u>Erosion and Sedimentation Control Act</u>

Another state law that prohibits development in riparian areas is the Georgia Erosion and Sedimentation Control Act of 1975 (O.C.G.A. 12-7-1 et.seq). This law prohibits land-disturbing activity within 25 feet of all state waters. State waters are defined as any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells, and other bodies of surface or subsurface water, natural or artificial, lying within or forming a part of the boundaries of the state, which are not entirely confined and retained completely upon the property of a single individual, partnership, or corporation (O.C.G.A. 12-7-3). Land disturbing activity includes but is not limited to excavating, grading and filling of land, all of which are common in land development. Unlike the environmental planning criteria, the Georgia Erosion and Sedimentation Control Act recognizes intermittent and ephemeral streams and lakes and ponds as state waters and affords them as much protection as perennial streams.

Under the Georgia Erosion and Sedimentation Control Act, streams that bear trout are afforded a protected 50-foot vegetated buffer. This larger buffer width is required because trout are more sensitive to increases in water temperature than warm water fish. A fifty-foot stream buffer is more protective of the surface and subsurface water temperatures that these fish depend upon.

<u>Relevant Local Environmental Planning Criteria</u>

Both the environmental planning criteria and the Erosion and Sedimentation Control Act allow local governments to adopt their own standards as long as they are no less stringent then state law. Cherokee and Forsyth Counties have adopted their own stream buffer ordinances. The Cherokee County Zoning Ordinance (Section 10.6-7) establishes a 50-foot undisturbed natural buffer along all primary and secondary streams and a 150-foot undisturbed natural buffer along the Etowah River. This ordinance does not define primary or secondary streams. Forsyth County's Unified Development Code (18-5.15) requires a 35-foot undisturbed natural buffer on all state waters. Dawson and Pickens counties do not have local stream buffer ordinances but have formally adopted the environmental planning criteria related to buffers. Lumpkin County is currently contesting the water supply watershed standards under the Georgia Planning Act, and have not officially adopted any stream buffer laws. No local governments in the Upper Etowah Region have established no-build zones for wetlands, mountain areas, groundwater recharge areas or water supply watersheds. Figure 3 illustrates the impervious surface setbacks and stream buffers protected throughout the Upper Etowah Region.

Metropolitan North Georgia Water Planning District

The Metropolitan North Georgia Water Planning District was established by the Georgia legislature in 2001 to address the pressing need for comprehensive water resources management in the 16-county area of metropolitan north Georgia (Metropolitan North Georgia Water Planning District, 2003). Each county within this district is required to adopt model stormwater and non-point source pollution ordinances to improve water quality and watershed integrity.

The district Board formally adopted five model ordinances on October 3, 2002 and each local government is expected to adopt these models or alternatives that are at least as restrictive (Metropolitan North Georgia Water Planning District, 2003). Forsyth and Cherokee counties are the two counties within the Upper Etowah Region that fall within this district.

The five ordinances that were approved do not impose impervious surface limits, density restrictions or stream buffer regulations upon local governments. However, a model stream buffer ordinance was prepared and reviewed for the October 3, 2002 meeting, but adoption was postponed to review the proposed buffer width and definition of streams (Metropolitan North Georgia Water Planning District, 2003). Although these regulations are forthcoming, they were not officially adopted by the completion of the Planned Scenario and are therefore not reflected here.

Extent of Protected Land in Planned Build-out Scenario

In the Planned Scenario, the percentage of protected land varies considerably throughout the Upper Etowah Region. A large proportion of Lumpkin and Pickens Counties is owned and managed by the federal Department of Agriculture as the Chattahoochee National Forest. Dawson County also has a large area of protected land managed by the Georgia Department of Natural Resources as Dawson Forest Wildlife Management Area and Amicalola State Park. The remaining counties only have a minor proportion of their land protected as federal, state or local parks or through regulation. Table 1 illustrates the total area of land that is protected as parkland or through the state and local environmental planning regulations described above. Although a deed restriction is needed to permanently protect land, this table illustrates the amount of land that is restricted from development at the writing of this document.

Table 1. Land protected through the Planned Build-out Scenario.

County	Total Acres	Acres Protected*	%Protected
Cherokee	271,082	36,683	13.5
Dawson	134,984	37,617	27.9
Forsyth	258,946	12,010	4.6
Lumpkin	183,452	64,549	35.2
Pickens	148,104	21,346	14.4

*All land restricted from development through fee simple ownership, lease or existing regulatory structures.

GIS Methods for Creating Planned Scenario

ArcView 3.2 GIS was used throughout the formation of the Planned Scenario. Lumpkin, Dawson and Pickens County's future land use maps were provided as shapefiles from the North Georgia and Georgia Mountain Regional Development Centers. Cherokee County's future land use map was provided as an Auto CAD image by the Cherokee County Planning Department. This image was rectified using Imagine software and digitized in ArcView 3.2. The resulting image was corrected using ArcInfo and the x-tools and geoprocessing extensions in ArcView 3.2 were used to merge adjoining polygons with similar land use attributes. An electronic copy of the Forsyth future land use map was not available from Forsyth County Planning and Zoning. A hard copy of this map was scanned into Photoshop, rectified in Imagine and digitized in ArcView 3.2. The resulting file was converted to an ArcInfo coverage and cleaned. Finally, this file was converted to a shapefile and simplified in ArcView 3.2 using the x-tools and geoprocessing extensions.

Alternative I Build-out Scenario

The Alternative I Scenario utilizes the same matrix as the Planned Scenario: the future land use maps created by the local governments within the Upper Etowah Region. The distinguishing characteristic of the Alternative I Scenario is that it incorporates additional sensitive natural areas as no-build zones. These areas include stream buffers, steep slopes, and wetlands. Although state law protects these natural areas to some degree as described above, the range and level of protection varies, leaving some areas vulnerable to degradation.

These significant natural areas are hydrologically connected. Therefore, the degradation of a significant natural area in one county may have impacts that can be observed downstream or in another county. An example of this is any land disturbing activity on steep slopes that contributes to the sedimentation of a wetland or stream. For this reason, a consistent, regional approach is needed to fully protect these sensitive natural areas. Figure 4 illustrates the Alternative I Scenario.

Stream Buffers

The Alternative I Scenario protects the vegetated corridors of all state waters by maintaining a 75-foot impervious surface setback around them. This setback replaces all stream buffers less than 75-feet, such as the 25, 35 and 50-foot buffers mandated by the Erosion and Sedimentation Control Law Act and Forsyth County's Unified Development Code (18-5.15), as illustrated in the Planned Scenario described above. The 75-foot recommended buffer does not replace stream buffers that exceed this width, because they are more protective of water quality and aquatic habitat. Therefore, the 100-foot and 150-foot buffers mandated under the environmental planning criteria and Cherokee

County's Zoning Ordinance (98-0-12) are maintained. A minimum fixed-width buffer of 75-feet on all perennial and intermittent waters is needed in order to maintain all the aquatic ecological functions described below.

One of the functions of riparian buffers is sediment retention. Sediment is the largest pollutant of streams in Georgia, in terms of volume (Cooper, 1993). Suspended sediment reduces prey detection by fish (Waters, 1995), can cause direct mortality of fish, reduces the abundance of filter feeding organisms such as mussels and aquatic insects and is costly to remove from drinking water (Wenger, 1999). Settling of sediment within the substrate of waterbodies smothers fish eggs and fry (Burkhead et al. 1997), homogenizes substrate habitat (Burkhead et al. 1997), and reduces the storage capacity of reservoirs (Wenger, 1999). Nutrient pollutants, such as phosphorus, also adhere to sediment and are transported downstream.

Riparian areas reduce sedimentation six ways: 1) by displacing land disturbing activities away from waterbodies; 2) by trapping sediment from overland flow; 3) by absorbing flood flows and contributing to the retention of these sediment-rich waters; 4) by slowing peak flows and reducing bed scour; 5) by stabilizing streambanks and reducing channel erosion; and 6) by contributing large woody debris, such as tree falls, that trap sediment (Wenger, 1999).

Riparian areas are also useful in the mitigation of nutrient pollution. An excess of nutrients, such as phosphorus and nitrogen, can lead to the euthrophication or overfertilization of waterbodies. The blooms of algae that are produced during euthrophication and the subsequent oxygen-consuming processes of respiration and decomposition can rob a waterbody of dissolved oxygen. In extreme cases, this has led to fish kills. Riparian areas reduce the likelihood and severity of phosphorus and nitrogen pulses into streams from overland flow, by capturing the sediment that these pollutants bind to.

Riparian buffers are more effective at removing nitrogen than phosphorus. This is especially important because nitrate and ammonium, two forms of nitrogen, have been found to be toxic to humans and many aquatic organisms at high concentrations. Riparian areas are more effective at removing nitrate because it is highly soluble. Vegetative uptake therefore is very common as long as nitrate comes in contact with the root zone. Denitrification or the conversion of nitrate into nitrogen gas by microorganisms is also very common in riparian areas. Riparian buffers of 20-30 m (66-98 feet) have been shown to remove nearly 100% of nitrate from overland flows (Wenger, 1999).

Stream buffers are also effective at reducing the presence of pesticides in surface water. In aquatic systems, pesticides can cause various sublethal effects as well as direct mortality to organisms (Cooper, 1993). Pesticides are applied to row crop agriculture and lawns and are transported to waterbodies via overland flow. The EPA estimates that over 70 million pounds of pesticides are applied to lawns every year (Wenger, 1999). Neary et al. (1993) observed high concentrations of pesticides were found in waterbodies only when riparian areas were absent or when the riparian area was violated (Wenger, 1999).

Stream buffers or riparian vegetation also provide essential nutrients and structure to waterbodies. Leaf deposition provides the nutrients that sustain aquatic invertebrate communities, the foundation of aquatic food webs. Large woody debris or snags also diversify in-stream habitat by creating hydraulics and eddies. The removal of large woody debris can have long-term effects on waterbodies. Of all the aquatic ecological functions provided by stream buffers, the loading of woody debris into waterbodies requires the longest time of recovery after stream buffer removal (Wenger, 1999).

Finally, riparian areas help moderate stream temperatures. Riparian forest shade cools surface water and shallow groundwater that feed streams. Freshwater aquatic organisms, especially cool water fish such as darters and trout, have a narrow tolerance for temperature variation. In fact, Barton et al. (1985) found that the only important factor affecting the presence of trout in streams was water temperature.

In order to maximize the stream buffer functions described above, a continuous 100-foot forested stream buffer is required (Wenger, 1999). Although a 100-foot stream buffer is ideal, a 75-foot buffer still exceeds the minimum recommendation made by Wenger (1999) and is more likely to be adopted region-wide. The Technical Coordinating Committee of the Metropolitan North Georgia Water Planning District also recommends a 75-foot buffer on all streams (Metropolitan North Georgia Water Planning District, 2003). This impending regulation coupled with Wenger's (1999) findings provides the basis for the 75-foot steam buffer designation on all perennial and intermittent waterbodies of the Alternative I Scenario.

Wetlands

Wetlands are known to provide a wealth of ecosystem services including wildlife habitat, groundwater discharge and recharge, flood mitigation, and water quality improvements (Mitsch and Gosselink, 2000). Wetlands help maintain the natural geomorphology of stream channels by capturing and slowing stormwater and reducing its erosive power. The biological processes common in wetlands, such as plant uptake of nutrients and sedimentation, modify the pollutant regime of runoff.

Natural wetlands remove pollutants through a variety of mechanisms, depending upon the nature of the pollutant. Sedimentation is one of the principal mechanisms. The deposition of suspended solids occurs in wetlands due to the decrease in velocity of receiving waters. The retention of suspended solids is dictated by particle size, hydrologic regime, flow velocity, residence time and storm surges, among others. Metals and nutrient pollutants tend to sorb to sediments and are trapped in wetlands during regular flows. Fecal coliforms also tend to be associated with particulate matter and settle in wetlands (Reinelt and Horner, 1995).

Plant uptake is also a common mechanism of pollutant removal in wetlands. Significant amounts of dissolved phosphorus can be taken up by vegetation during the growing season (Reinelt and Horner, 1995). Ion exchange also occurs in wetlands allowing pollutants to change forms. Once metals become soluble, they are available for plant uptake.

Phosphorus is a nutrient pollutant that when abundant in surface waters can lead to euthrophication and dissolved oxygen deprivation. Phosphorus is also a common element in the human landscape as it is a key component of wastewater effluent and agriculture and urban runoff. Reinelt and Horner (1995) found that 7.5% and 82.4% of total phosphorus was removed by two palustrine wetlands in Washington. The wetland responsible for the removal of 82.4% of total phosphorus drained a smaller, more forested watershed thus contributing less total phosphorus inputs. The longer residence time also contributed to the greater removal of total phosphorus here.

The retention of phosphorus in wetlands tends to vary considerably throughout the year. Plant uptake is the primary mechanism of phosphorus removal, so retention is maximized during the growing season. A marsh adjacent to Lake Wingra, Wisconsin retained 83% of the P input in the summer but only 1% in the fall and 8% in the spring. This resulted in an annual retention of 10% (Loucks et al., 1978).

Studies in the southeast United States suggest that wetlands are equally as effective at retaining phosphorus as wetlands in Washington or Wisconsin. Lowrance et al. (1984) found that 30% of the phosphorus input from agriculture runoff from a watershed in Georgia was retained by a forested wetland. These values were low compared to the findings by Skaggs et al. (1980). In the Skaggs study, two scrub/shrub wetlands in North Carolina were found to retain 66.7 and 75% of their phosphorus inputs. The annual inputs of phosphorus for these wetlands (1.2 and 0.8 $kg \bullet ha^{-1} \bullet y^{-1}$, respectively) were much smaller than the annual inputs (5.6 $kg \bullet ha^{-1} \bullet y^{-1}$) of the Lowrance et al. wetlands, suggesting again an inverted relationship between input volume and percent retention.

Fecal coliforms, an indicator of disease bearing microorganisms, are a natural constituent of streams. These microorganisms populate the intestines of warm-blooded animals and are transferred to surface waters through excrement. An overabundance of fecal coliform bacteria is common in agriculture dominated watersheds or watersheds containing malfunctioning sewer or septic systems. Wetlands have also been found to remove substantial amounts of fecal coliform from receiving waters and are associated with stream reaches containing relatively small amounts of fecal coliform bacteria.

Reinelt and Horner (1995) found that 49.1 and 29.0% of fecal coliform colonies were removed by wetlands draining urban and forest dominated wetlands, respectively. The authors speculated that sedimentation, vegetation filtration and bacterial die-off were the mechanisms responsible for fecal coliform removal. Johnston et al. (1990) used a landscape approach to explore the relationship between watershed attributes, including wetlands, and water quality variables in the Minneapolis-St. Paul, Minnesota area. Through historical air photo and water quality examination, the authors were able to use principal component analysis to determine the watershed attributes that were the most highly correlated with water quality. Their findings suggested that fecal coliform concentration was negatively correlated with the proximity to wetlands. Similarly, Tilton and Kadlec (1979) found that natural wetlands receiving wastewater discharge decrease fecal coliform concentrations. The authors speculated that sedimentation and bacterial die-off are the primary mechanisms responsible for the removal.

Total suspended solids by themselves are not toxic. However, as mentioned above, fecal coliforms and nutrient pollutants tend to sorb to particulate matter. Therefore, the reduction of suspended solids is an effective way of controlling these pollutants. Reinelt and Horner (1995) found that 13.6 and 56.5% of the total suspended solids entering two palustrine wetlands were removed at each wetland outlet. Total suspended solid retention varies with flow; during baseflow, wetland inputs contain small amounts of suspended solids while wetland releases contain a relatively large amount of fine sediment particles and organic matter. This resulted in a net gain of sediment from the wetland draining an urban watershed in the Reinelt and Horner (1995) study. Although the retention of suspended solids varies with flow, watershed land cover, retention time, and available storage capacity, wetlands clearly trap sediments and reduce the likelihood of pollutant transport.

Kao and Wu (2001) confirmed this observation by studying the non-point source pollution loadings of a 7,822 m^2 mountainous wetland in North Carolina. During a six-day storm event, 1,107 kg of the 1,216 kg of sediment discharged into the wetland were retained by the wetland, a 91% removal rate. During baseflow, this trend was more modest. The authors found a 79% decrease in total suspended solid concentration during these conditions.

Wetland Class and Extent in The Upper Etowah Region

Two classes of wetlands are located in the Upper Etowah Region. Riverine wetland systems include all the wetlands and deepwater habitats located within the channel of waterbodies, and are either void of vegetation or are characterized by nonpersistent emergent vegetation (Cowardin et al., 1979). Stream channels are regulated under Section 404 of the federal Clean Water Act. Therefore, riverine system wetlands and deepwater habitats are not discussed here.

Approximately 3,071 hectares (7,589 acres) of palustrine wetlands are located in the Upper Etowah Region (United States Fish and Wildlife Service, 2002). Trees, shrubs, persistent emergents, and/or persistent mosses or lichens characterize these wetlands. When vegetation is lacking, palustrine wetlands are defined by the four following characteristics: 1) total area less than eight hectares, 2) bedrock or wave-formed shoreline lacking, 3) maximum depth less than 2 m during dry season, and 4) salinity due to ocean derived salts not exceeding 0.5% (Cowardin et al., 1979).

The most common palustrine wetland in the Upper Etowah Region is the permanently flooded, unconsolidated bottom type. This class of wetland is open, containing a forest cover of less than 30% and generally has a very unstable surface. Forested wetlands are the second most common class of wetlands located in this area. These wetlands are dominated by broadleaf trees and can be temporarily or seasonally flooded. The third major class of wetland found in this area is scrub/shrub wetlands. A scrub/shrub wetland is dominated by vegetation that is less than 6 meters in height. The vegetation found here can be true shrubs, young trees, or shrubs and trees that are stunted because of local environmental conditions. This class of wetland is also known as shrub swamps and bogs (Cowardin et al., 1979).

Recent Changes in Wetland Law

The 2001 Supreme Court case of *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers* (SWANCC) has dramatically affected the protection of wetlands across the United States and in the Upper Etowah Region. This case removes the category of isolated wetlands from federal jurisdiction. Prior to the SWANCC case, the federal Army Corps of Engineers had authority to regulate through a permit system the discharge of dredged or fill material into "the waters of the United States", including non-navigable waters whose use or misuse could affect interstate commerce (Stevens, 2001). These waters included isolated lakes and wetlands, intermittent streams, prairie potholes, and other waters that are not part of a tributary system to the interstate waters or to navigable waters of the United States (33 CFR § 328.3). The SWANCC case categorically relinquished all waterbodies with no apparent surface water connection to perennial rivers or streams, estuaries or the ocean from federal protection against filling (Tiner et al., 2002), and returned these powers to the states.

Georgia has no state law protecting inland wetlands and relies on the federal government for issuing fill permits. Therefore, currently no agency in Georgia is responsible for the regulation of isolated wetlands. These areas are open for development without consideration of the environmental costs and without the requirement of mitigation.

Isolated wetlands constitute a significant proportion of the wetlands throughout the United States and Georgia. In Tiner et al. (2002), the U.S. Fish and Wildlife Service provided an overview of the types, functions and values of isolated wetlands along with general estimates of the number and acreage of these wetlands in a variety of physiographic settings across the country. Tiner et al. (2002) found that between 25.6 and 29.2% of all the wetlands in the Acworth study area were classified as isolated. This 64,066-hectare (158,320 acre) study area is partially located in southeastern Cherokee County, one of the five counties of the Upper Etowah Region. It is reasonable to assume that a large proportion of the wetlands located in the Upper Etowah Region are the isolated type and are no longer protected through federal regulatory control. This recent change in wetland law compels state and local governments to adopt legislation protecting these sensitive natural areas.

Steep Slopes

The upper Piedmont and Southern Blue Ridge ecoregions, both of which are characterized by rolling hills with moderately steep topography, comprise the Upper Etowah Region. Steep slopes are generally coupled with aspect when their ecological merits are discussed. Rich and sometimes rare plant communities can be found along north-facing mesic hillsides in both the Southern Blue Ridge and upper Piedmont ecoregions. Steep slopes are also fragile and provide the greatest potential for erosion. In fact, the Soil Conservation Service (currently: Natural Resource Conservation Service) recommends the protection of forested slopes in excess of 12°(21.25%) (McHarg, 1992).

Some local and state governments throughout the United States have recognized the merits of steep slopes by adopting ordinances to protect them. However, erosion control and the protection of rare plant communities are not the only values that governments have referred to in their policies. Along with natural phenomena (river corridors, vegetation, habitats and soils) protection, Olsansky (1998) found that the protection of aesthetics and the avoidance of geologic hazards (landslides) were the top purposes for hillside protection in the 190 hillside plans and ordinances he sampled across the United States. Other highly valuable purposes identified here were health, safety and general welfare (foundation stability), natural resource (water supply and open space) protection, access and fire protection.

The most common planning solution to protecting hillsides is to restrict housing densities based on the steepness of slope. In fact, the State of Georgia restricts residential densities on slopes greater than 25% and above 2,200 feet mean sea level for the purposes of protecting surface water, ground water and aesthetics and the prevention of landslides and wildlife habitat damage (Chapter 391-3-16). Although the establishment of various housing densities based on the steepness of slope is a common policy tool, it is not feasible to model at the scale of the Upper Etowah Region. Therefore, a single percent slope (25%) was selected for this study and development was restricted above this threshold. Areas exceeding 25% slope require an enormous amount of cut and fill and are therefore highly unsuitable for development (Steinitz, 1996). McHarg (1992) also recommends that these areas are kept forested.

Extent of Sensitive Natural Areas and Existing Protected Land

The protection of the sensitive natural areas described above has varying effects on the amount of land available for development throughout the Upper Etowah Region. The amount of land protected by setting aside wetlands, steep slopes and stream buffers in Cherokee County was marginal; only 2.3% of this county fell into these land categories. Pickens County, however, contains a large amount of steep land that would be protected with this approach. In fact, an additional 24,723 acres or 16.7% of the county would be undevelopable due to the presence of steep slopes, wetlands and stream buffers. Table 2 lists the total and percent-protected land per county that would be achieved through existing mechanisms and by protecting the sensitive natural areas described above. This figure is not limited to areas permanently protected through a deed restriction.

Table 2. Land protected through the Alternative I Build-out Scenario.

County	Total Acres	*Existing Protected Acres	**Alternative I Protected Acres	Existing %Protected	Alter. I %Protected
Cherokee	271,082	36,683	42,964	13.5	15.8
Dawson	134,984	37,617	49,532	27.9	36.7
Forsyth	258,946	12,010	9,566	4.6	7.6
Lumpkin	183,452	64,549	81,911	35.2	44.9
Pickens	148,104	21,346	46,069	14.4	31.1

*All land currently restricted from development through fee simple ownership, lease or existing regulatory structures.
**All land restricted from development through fee simple ownership, lease or proposed regulatory structures.

Alternative II Build-out Scenario

The Alternative II Scenario departs from the conventional future land use map matrix of segregated land use in the form of separate residential, commercial, and industrial areas and employs watershed-based zoning and mixed-use clustering concepts. Conventional land use planning cannot effectively protect urban streams from degradation because it only restricts the number of dwelling units per acre, not the total impervious area (TIA) of a watershed. Watershed-based zoning is based on the conclusion that it is extremely difficult to maintain predevelopment stream quality after watershed TIA has exceeded 10% of the total watershed area (Center for Watershed Protection, 1996). Under this approach, each watershed is classified by its existing aquatic ecological integrity and protected through the restriction of an appropriate TIA.

The Alternative II Scenario also employs mixed-use clustering. This approach protects large areas of intact open space, reduces the extent and cost of community services such as roads, sewer and water lines and fosters the development of traditional neighborhoods. Mixed-use clustering is a compact form of development that interweaves residential, commercial, office and public spaces in a pedestrian-friendly layout, providing recreational, employment, and entertainment opportunities all within walking distance of a residence. This is contrary to conventional suburban development which separates residential land use from all other land uses and focuses on the automobile as the transportation unit. Forsyth and Cherokee counties have begun to recognize the benefits of mixed-use clustering and have encouraged their development by labeling areas on their future land use maps as Planned Unit Development, Mixed-use Corridor, Village, Community and Neighborhood.

Impervious Surface Basis for Planning

Aquatic resources are adversely affected by stormwater runoff from impervious surfaces. Impervious surfaces are materials that prevent the infiltration of water into the soil and include areas such as rooftops, roads, parking lots, driveways, sidewalks and compacted soil. Impervious surface replaces natural ground cover as an area becomes developed. The relationship between impervious cover and human habitation has become so significant that population density can be estimated by percentage of impervious cover (American Planning Association, 1996).

Natural landscapes transport the majority of precipitation in the form of interflow or groundwater flow. Conversely, developed areas prohibit the movement of water through soil and become dominated by overland flow or stormwater runoff (Figure 5). This functional shift in the transport of water from subsurface processes to stormwater runoff is the primary cause of water quality degradation in developed areas. Consequences of this shift include the reduction of baseflows, an increase in stormflows, the predominance of fine sediments, bank instability and incision, and an alteration of in-stream habitat and biotic assemblages.

The effects of various amounts of impervious surface on aquatic habitat have been well researched (Booth and Jackson, 1997; Booth et al., 1996; Finkenbine et al., 2000; Jones and Clark, 1987; Klein, 1979; Masterson and Bannerman, 1994; Wang et al., 2000; and Yoder and Miltner, 2000). Although these studies were conducted in various ecoregions and used differing methods, their results show similar trends. Generally, aquatic degradation is first observed where percent watershed imperviousness approaches 10%. Between 11 and 25% watershed imperviousness, streams become degraded, experiencing less stable channels, declining water quality and biological diversity. Watersheds with percent imperviousness greater than 25% are described as non-supporting, meaning that predevelopment stream channel stability and water quality cannot be maintained (Center for Watershed Protection, 1996). Figure 6 illustrates the relationship between imperviousness and stream health.

Watershed Protection Districts

Since water quality and stream habitat are largely impacted by TIA, limiting watershed TIA is the primary strategy of the Alternative II Scenario. This is achieved through the formation of Watershed Protection Districts. The boundaries of these districts are based on the 12-digit hydrologic unit codes (HUCs) published by the United States Geological Survey (USGS). Each HUC generally ranges from 10-20 mi^2 in area and the effects of TIA on aquatic resources are moderately strong at this scale (Center for Watershed Protection, 1996). The relationship between TIA and aquatic impact becomes stronger with decreasing watershed size. In fact, the ideal watershed unit for implementing these TIA controls is a catchment (0.05-0.50 mi^2) (Center for Watershed Protection, 1996). However, this is not a practical unit for watershed planning in an area the size of the Upper Etowah Region (1,414 mi^2).

The next step in the formation of Watershed Protection Districts is the prescription of TIA controls. These controls are based on two data sets, the prioritization of tributary systems for aquatic species protection and the existing amount of impervious surface.

Prioritization of Tributary Systems

The prioritization of tributary systems was conducted on the subwatersheds that form the Etowah basin, as part of the Etowah Regional Habitat Conservation Plan. This prioritization scheme composes four levels. High priority tributary systems are located at the top of the Etowah basin and include the Etowah headwaters, Amicalola Creek and Shoal Creek in Dawson County. These systems, collectively, provide habitat for Cherokee and Etowah darters and both species of holiday darters. These systems also are largely responsible for the high quality conditions of the Etowah River mainstem, which is also a high priority system.

Medium-high priority tributary systems include Shoal Creek in Cherokee County, Long Swamp Creek and Sharp Mountain Creek. These tributary systems are important for the persistence of large stream and mainstem species. Amber darters are also found in the lower portions of Shoal and Sharp Mountain creeks in Cherokee County.

Medium-low priority tributary systems are significantly less important to the overall viability of imperiled aquatic species. This is chiefly due to the fact that these systems are much smaller. The only systems in this region that have this classification are the small Etowah River tributaries. These are direct tributaries to the Etowah River and may provide habitat for Cherokee darters, but their small and isolated nature translates into a smaller contribution to the long-term viability of these species and to the species that inhabit the mainstem of the Etowah River.

Low priority tributary systems may contain imperiled species, but are either isolated by impoundments or are degraded to the extent that they are not expected to be of significant value in the long-term survival of these species. Settingdown Creek is the only tributary system in the Upper Etowah Region that is designated as a low priority. Imperiled species are not regularly found in this system and the impacts of agriculture use are visible. Isolated subwatersheds that meet these criteria are also designated as a low priority.

Data regarding the ecological significance of Chattahoochee and Coosawatee subwatersheds were not available. Therefore, the subwatersheds of these basins were not assigned a protection priority. Figure 7 illustrates the extent of the tributary system protection priorities.

These data were then generalized from a subwatershed to a watershed scale so that they could be most effectively incorporated into Watershed Protection Districts. There was very little variability between the protection priorities of subwatersheds that formed each HUC. The only areas where subwatershed priority varied within a given HUC were those that included the mainstem of the Etowah River. In this case, the HUC was given a priority 1 or 2 depending upon the priority and extent of the contributing non-mainstem subwatersheds.

Existing Impervious Surface Analysis

Existing percent impervious surface was assessed on the watershed scale. This process began with the recalculation of the Landsat TM 1998 land cover within the upper Etowah subbasin, from 30m to 15m resolution. The purpose of this recalculation was to reduce the over-estimation of transportation cover in the original land cover. The built component of the Landsat TM 1998 land cover was then unioned with the HUCs using Arcview 3.2. Three built land cover types are recognized, low and high intensity urban and transportation.

The calculation of existing total impervious area per HUC was completed by multiplying the total area of each built land cover class in each HUC by an impervious surface coefficient. The percent impervious surface coefficient was calculated exclusively for the upper Etowah subbasin using the Landsat TM 1998 land cover. The methodology used to assess this coefficient consisted of distributing random points across the entire subbasin and analyzing the points that fell on low or high-intensity urban classes.

USGS ortho-corrected color infrared photos (1999) were used to classify each of these points (over 500 points total) as pervious or impervious (roads, rooftops, parking lots, etc.). Only the data for the low and medium population counties (Cherokee, Forsyth, Dawson, Pickens, and Lumpkin) were included since the high population counties (Cobb and Fulton) are not included in this project and may have skewed the results. The results from this study showed that the percent impervious surface for low and high-intensity urban classes were 23 and 46% respectively. The percent impervious surface for transportation was estimated at 100%. These coefficients were multiplied by the total acreage of each class in each HUC and divided by the total HUC acreage to derive existing percent impervious surface estimates. Figure 8 illustrates the existing percent impervious surface per watershed in the Upper Etowah Region.

Methods of Forming Watershed Protection Districts

Three districts were formed based upon the tributary system prioritization and existing impervious surface analysis discussed above. Two of these three districts limit the TIA per watershed while the third district has no TIA limits. The Low Intensity District restricts TIA to 10%. These watersheds generally provide high quality critical habitat for aquatic imperiled species or significantly contribute to the persistence of critical Etowah River mainstem habitat, have the smallest amount of existing impervious surface and are therefore the most susceptible to the impacts expected from further development.

The Medium Intensity District limits TIA to ≤ 25%. Some of these watersheds in this district are important to the persistence of critical mainstem aquatic habitat or provide critical habitat for Cherokee darters, but have already exceeded the 10% threshold. This district also includes watersheds that have an existing impervious surface <10% but that are not important to the long-term survival of imperiled fish species. Although these watersheds are not critical to the protection of imperiled biota, the existing low TIA warrants restrictions on the amount of urbanization allowed.

Finally, the High Intensity District has no TIA restrictions. The watersheds that form this district are not a tributary system priority and have existing impervious surface limits that exceed 10%. Table 4 lists the criteria for each district and Figure 9 illustrates the location of the Watershed Protection Districts throughout the Upper Etowah Region.

Table 3. Criteria for meeting Watershed Protection Districts.

District	TIA Restriction	Tributary System Priority	Existing TIA
Low	10%	High or Medium-High	0-9%
Low	10%	Unavailable*	0-5%
Medium	25%	Med.-High or Med.-Low	10-25%
Medium	25%	Unavailable*	6-25%
Medium	25%	Low	0-9%
High	Unlimited	Low	10-25%

*Data not available because watersheds are in the Coosawatee or Chattahoochee basins and not the Upper Etowah Basin
**All watersheds that immediately drain into Lake Lanier were classified into Medium Districts

Township and Rural Zoning

Once TIA limits were established through the formation of Watershed Protection Districts, the extent of future development was calculated and mapped. To do this, Township Zones (TZ) were mapped in areas that already provided the community utilities needed for urban development. These areas included the cities and surrounding areas of Ball Ground, Canton, Cumming, Dahlonega, Holly Springs, Jasper, Nelson, Talking Rock, Waleska and Woodstock.

The TZ requires an average residential density of 4 units/acre, a density that is common to traditional neighborhood development. Traditional neighborhood development is a mixed-use development pattern that reflects the characteristics of small, older communities of the 19th and early 20th centuries. Emphasis is placed on a grid-like layout of the streets, a variety of housing types with smaller front yards, the judicious use of open space, the formation of community focal points and clearly defined streetscapes. The overall objective of this type of development is to create a sense of community by creating pedestrian connections between homes, public spaces, jobs and shopping areas (Beyond Sprawl, 1997). It is important to repeat that this type of development pattern includes all forms of housing types, including single-family detached homes. These homes are generally placed on smaller lots and have shorter setbacks than single-family detached homes in conventional subdivisions.

Traditional neighborhood development is not foreign to this region. The Vickery project in Forsyth County was approved by the Board of Commissioners in October 2000. This 12-year project will culminate in the construction of 600 residential units and

150,000 square feet of commercial space. Housing types will include single-family detached, live/work townhouses and lofts. Retail, office and civic space is also planned.

Under the Alternative II Scenario, the area within each watershed that is not zoned as Township will be zoned as Rural. Housing density in the Rural Zone will be reduced to 1-unit/10 acres. This low-density zoning will encourage housing development within the TZ, where community utilities are already available, and will protect the rural character of these outlying areas. A density rate of 1-unit/10 acres is also not foreign to the Upper Etowah Region. The Pickens County Land Use Intensity Ordinance requires a 1-unit/10 acre density in the areas of the county mapped as Forest/Agriculture (Vanden Bosch, personal comment (b)).

GIS Method for Mapping Township and Rural Zones

The extent and placement of TZs has to be deliberate in order to meet the housing needs outlined in the counties' comprehensive land use plans without exceeding the restricted TIA per watershed. This process began by identifying the maximum acreage of impervious surface that each watershed could provide without surpassing its %TIA dictated by its Watershed Protection District. The existing impervious acreage was subtracted from this maximum to determine the additional available impervious acreage per watershed. For practical purposes, all land uses within the TZ were considered mixed-uses and were assigned a 27.8% impervious rate. The percent imperviousness of mixed-use areas varies considerably depending upon the dominant land uses and compactness of the development located there. Research identifying the percent impervious rates of mixed-use areas has not been conducted. Since the overall residential density of each township is estimated at 4 units/acre, an impervious rate of 27.8% was selected. This impervious rate corresponded with Cappiella and Brown's (2001) published value for 1/4-acre lot residential land uses.

The TZs were first delineated in the High Intensity Watershed Protection Districts since these areas are not critically important to aquatic imperiled species. The two cities that are located within these Districts are Woodstock and Holly Springs. The TZs in this area were drawn to reflect the extent of these city boundaries. The TZ could have extended well beyond these boundaries, since no TIA restrictions apply in these districts, but were limited to the extent of the incorporated city for two reasons. First, the Landsat TM 1998 land cover clearly showed that there were hundreds of undeveloped acres within the Woodstock and Holly Springs city limits. In fact, these city boundaries have had very little impact on the spread of development in this area of Cherokee County. Concentrating growth within these cities through the adoption of Township and Rural Zones will help maintain Woodstock and Holly Springs as town centers.

Second, although there is presumably enough undeveloped land in Cherokee County alone to provide housing for the 2015 projected population of the Upper Etowah Region (622,793 people), directing all the development into this area is acceptable to neither Cherokee nor the remaining counties in the Upper Etowah Region. Each of the five counties have already made significant investments in their county seats and cities. Locating all the development within one county or one High Intensity District, although beneficial to the priority headwater tributary systems and mainstem of the Etowah River, is not equitable. Therefore, TZs were limited to the extent of the Woodstock and Holly Springs boundaries in the High Intensity Watershed Protection District.

The second area in which TZs are located is in the Medium Intensity Districts. Both Cumming and part of Canton are located in these Districts. The existing TIA for the watersheds that comprise these cities is relatively low, between 5-11%. Therefore, between 20-14% of the remaining land within each watershed is still available for development without exceeding the 25% threshold. This phenomenon required the TZs in these districts to expand beyond the city boundaries.

The TZ area for these cities was calculated using ArcView 3.2. Once the additional impervious surface allowed without exceeding the 25%TIA was calculated, the size of the TZ could be calculated. It was assumed that 90% of the additional impervious surface would occur in the TZs while only 10% would occur in the Rural Zones (a conservative estimate since the density in the TZ is 40 times higher than the density permitted in the Rural Zone). Therefore, the additional impervious surface allowed per watershed was multiplied by 90%. This acreage provided a crude estimate of the size of the each TZ. Temporary TZs were then mapped. Whenever possible, the boundaries of these zones were drawn to include existing city boundaries, areas with existing high-density development and areas expected to have a minimal impact on water quality (catchments already significantly developed or areas near the outlet of watersheds).

Horner et al (1996) and Finkenbine et al (2000) found that intact stream buffers can mitigate the impacts of urbanization exceeding 20% TIA. Therefore, the significant natural areas set aside as no-build zones in the Alternative I Scenario are kept throughout this scenario. These data, along with the existing built area, needed to be accounted for in the estimation of each TZ. Accordingly, all significant natural and existing built areas were identified in each temporary TZ. These areas were added to the acreage of each temporary TZ and a new, larger TZ was drawn, following the same guidelines described above.

The final area in which TZs are located is in the Low Intensity District. The same methods were used here to determine the additional impervious surface allowed without exceeding the maximum TIA and for drawing and calculating the extent of significant natural and existing built area in the temporary TZ. Finally, the guidelines used for drawing the TZ in the Medium and High Intensity Districts were also used in the Low Intensity District. Because the extent of impervious area was more restricted in the Low Intensity District, the size of the TZs tended to be much smaller. TZs in the Low Intensity Districts were aggregated around Ball Ground, Dahlonega, Dawsonville, Jasper, Nelson, Talking Rock, Waleska and parts of Canton. Figure 10 illustrates the Alternative II Scenario.

Population Estimate of the Alternative II Build-out Scenario

The Alternative II Scenario concentrates development into townships without reducing projected population growth. In fact, while comprehensive land use plans project the addition of 322,485 new residents to the Upper Etowah Region by 2015, the Alternative II Scenario provides housing for 412,724 new residents by 2015.

This population estimate was made using ArcView 3.2. The expected population of all townships at build-out is 273,048. This number was calculated by subtracting the existing built and significant natural areas from the Township Zone polygons. The remaining acreage (25,282 acres) was multiplied by four (four-unit/acre density average) to derive the total number of housing units at build-out (101,129). The national average of 2.7 occupants per household (Fodor, 1999) was used to calculate the total number of people expected to inhabit the townships at build-out (273,048). This number alone comes close to meeting the housing needs established in the comprehensive land use plans for the projected number of new residents (322,485).

The Rural Zone allows housing at a density of 1 unit per 10 acres. The available housing in the Rural Zone was calculated by subtracting the existing built area, waterbodies and significant natural areas from this zone. The remaining area (517,323 acres) was multiplied by 0.10 to calculate the total units allowed (51,732 units). The population estimate for the Rural Zone was then calculated by multiplying the total number of units by 2.7, the assumed average of people per unit. The population estimate for the Rural Zone at build-out is 139,676. By combining the population estimates of the township and rural areas at build-out, while excluding the appropriate significant natural areas and existing built areas, a total population projection of 412,724 people is estimated. Clearly, this alternative plan will not hinder population growth.

CHAPTER 3

BUILD-OUT SCENARIO ANALYSIS

None of the three build-out scenarios can be recommended without an objective analysis of their environmental, cultural and economic impacts. Relatively simple methods including a GIS and published findings were used to assess the impacts of each scenario on stream health, the rural character of the region and the costs of community services incurred by local governments.

Aquatic Impact

Initially, the aquatic impact analysis was going to be conducted with a continuous, physically based GIS model known as SWAT. This model did not perform properly and was abandoned. The Soil Conservation Service method is a single event, empirical model that was investigated for use in determining the volume of runoff from each scenario. After discussion with experts, this method was deemed inappropriate for use in an area the size of the Upper Etowah Region. Finally, the percent total impervious surface per watershed was analyzed to determine the projected impact to stream health from each build-out scenario. A description of each method and the results from the percent impervious surface study follow.

SWAT Methodology

SWAT is an acronym for the Soil and Water Assessment Tool, a watershed-scale hydrologic model developed for the United States Department of Agriculture.

SWAT was developed to predict the impact of land management practices on water, sediment and agricultural chemical yields in large, complex watersheds with varying soils, land use and management conditions over long periods of time (SWAT User's Manual, Version 2000). This model is not limited for use in agricultural landscapes; rather it can be customized to show the hydrologic and pollution impacts of various build-out scenarios.

The SWAT model is physically based, requiring custom weather, soil property, topography, vegetation, and land management practice inputs for each modeled watershed. These input data allow the model to directly route water, sediment and nutrients throughout a defined stream network. One of the greatest benefits of this model over others is its ability to model ungaged basins. The upper Etowah subbasin does not have river gages within each 12-digit HUC. Therefore, a hydrological model that could calculate flow from the inputs described above was ideal.

The SWAT model is a continuous model, enabling users to study long-term impacts of management strategies or build-out scenarios. Daily, monthly or annual flows can be simulated with SWAT and the term of the model is equivalent to the term of the input data provided, i.e. a project with 10 years of daily precipitation data can provide 10 years of flow data. This type of model was preferred over single event models that simulate flows for a single given rain event.

The user's manual claims that SWAT is computationally efficient and that the simulation of very large basins or a variety of management strategies can be performed without excessive investment of time or money. This was proven false. Three months of full-time work were dedicated to setting up and running a SWAT project to model the effects of each of the three build-out scenarios on in-stream sediment and flow. A simulation was never successfully completed.

<u>SWAT's Deficiencies</u>

Although SWAT was initially the model of choice, it ultimately failed. The major non-computationally efficient problems encountered included:

- The inability to use 30m DEMs for watershed delineations. The Automatic Delineation tool allowed the import of 30m DEMs, the highest resolution DEM available at the time, for use in defining the study watersheds. After numerous attempts and consistent errors, this approach was abandoned and a lower resolution 90m DEM was used.
- The inability to use .xls format for the weather input files. SWAT's graphic user interface allows daily precipitation, temperature, solar radiation, wind speed, relative humidity and potential evapotranspiration values as model inputs in either .xls or .txt formats. However, after inputing seven years of daily temperature and precipitation data and four years of daily evapotranspiration data (over 6,500 manual records) in .xls format, the model continued to stall. By changing the format of these files into a .txt document, the Weather Generator worked successfully. It was later confirmed that although SWAT's graphic user interface accepts .xls formats, it prefers inputs in .txt format (Byne, personal comment).
- Error in writing the configuration (.fig) file. SWAT runs on a command line structure. The codes for these commands are generated automatically throughout the simulation process. The user has the option of manually customizing the command structure to fit their needs or to model unique circumstances. Once the .fig file is

written, the remaining input files are supposed to be automatically coded for the simulation. The .fig file was never successfully automatically coded in this project. Next, these files were manually accessed and simplified to initiate simulation. The simulation was still not completed, however. Expert opinion was sought both locally and through the BASINS listserve provided by EPA. The solution was to troubleshoot by dumping the project files into DOS and to run the simulation from there, as opposed to the SWAT software downloaded from EPA and recommended in the user's manual. The DOS procedures were not outlined in the user's manual and required a higher level of computer programming expertise than was available. This error is common as two SWAT users used the BASINS listserve to request the same help in March and April 2003 alone (BASINS listserve). These users had not found a solution to this problem as of the writing of this report.

The incomplete configuration file was the last straw. After three months of writing and rewriting files, seeking local and online help, and receiving nothing but error messages, SWAT was abandoned.

<u>SCS Method</u>

The SCS or Soil Conservation Service method is an empirical equation used to estimate the amounts of runoff under varying land use and soil conditions. This method was developed in the 1950s and was a product of more than 20 years of studies involving rainfall-runoff relationships from small rural watersheds across the United States (SWAT User's Manual, Version 2000). While SWAT is a continuous, physical-based, model producing estimates of in-stream flow and pollutant loads, the SCS method is a single event regression-based method that only produces estimates of runoff depth. The SCS method is not the most sophisticated method available, and its use has primarily been relegated to the sizing of conveyance structures such as stormwater pipes (Jackson, personal comment (a)).

The SCS curve number equation (SCS, 1972) is:

$$Q_{surf} = \frac{(R_{day} - I_a)^2}{(R_{day} - I_a + S)}$$

Where Q_{surf} is the accumulated runoff, R_{day} is the rainfall depth for the day, I_a is the initial abstractions which include surface storage, interception and infiltration prior to runoff, and S is the retention parameter. The retention parameter varies spatially due to changes in soils, land use, management and slope and temporally due to changes in soil water content. The retention parameter is defined as:

$$S = 25.4\ (1000/CN - 10)$$

where CN is the curve number of the day. The initial abstraction, Ia, is commonly approximated as 0.2S (SWAT User's Manual, Version 2000).

Solving the equation for a given rain event begins with assigning a CN for a given land use and soil condition. Table 4 is an example of the CNs published for cultivated agricultural lands by the SCS Engineering Division, 1986. CNs are also published for other agriculture lands and for urban areas.

The last step before completing the equation is to define the hydrologic soil group by the infiltration characteristics of the soils. Soil properties that influence runoff potential include depth to seasonally high water table, saturated hydraulic conductivity, and depth to a very slowly permeable layer (SWAT User's Manual, Version 2000). Table 5 lists the definitions of each of the four hydrologic soil conditions.

Table 4. Runoff curve numbers (CNs) for cultivated agricultural lands.

Land Use	Cover: Treatment or practice	Hydrologic condition	Hydrologic Soil Group: A	B	C	D
Fallow	Bare soil	- - - -	77	86	91	94
	Crop residue cover	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row	Poor	72	81	88	91
		Good	67	78	85	89
	Straight row w/ residue	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured	Poor	70	79	84	88
		Good	65	75	82	86
	Contoured w/ residue	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced	Poor	66	74	80	82
		Good	62	71	78	81
	Contoured & terraced w/ residue	Poor	65	73	79	81
		Good	61	70	77	80
Small grains	Straight row	Poor	65	76	84	88
		Good	63	75	83	87

Once the hydrologic soil conditions are combined with the land use, the CN can be estimated. The only other value needed to estimate the volume of runoff is the rainfall depth of the day.

SCS Method's Deficiencies

The primary deficiency of this method is its oversimplification. The amount of runoff from a given land use and soil type is not consistent. Varying conditions such as the soil water content, soil compactness, management characteristics, and slope are not effectively accounted for by the retention factor (S). Debate exists regarding whether or not the SCS Method is acceptable for measuring runoff from large mixed land use and soil watersheds.

Table 5. National Resource Conservation Service hydrologic soil condition definitions.

A:	(Low runoff potential). The soils have a high infiltration rate even when thoroughly wetted. They chiefly consist of deep, well drained to excessively drained sands or gravels. They have a high rate of water transmission.
B:	The soils have a moderate infiltration rate when thoroughly wetted. They chiefly are moderately deep to deep, moderately well-drained to well-drained soils that have moderately fine to moderately coarse textures. They have a moderate rate of water transmission.
C:	The soils have a slow infiltration rate when thoroughly wetted. They chiefly have a layer that impedes downward movement of water or have moderately fine to fine texture. They have a slow rate of water transmission.
D.	(High runoff potential). The soils have a very slow infiltration rate when thoroughly wetted. They chiefly consist of clay soils that have a high swelling potential, soils that have a permanent water table, soils that have a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. They have a very slow rate of water transmission.

Dickey et al. (1979) recommends the use of the SCS Method in watersheds 2,000 acres or less, while the U.S Soil Conservation Service (1986) suggests that this method can be used on watersheds up to 20 mi^2. Given this uncertainty, the oversimplification of this approach, and the resulting magnitude of error expected from this method at this scale (Jackson, personal comment (b)), this approach was also abandoned for use in the aquatic impact analysis of the three build-out scenarios.

Total Impervious Area per Watershed

Given the breadth of research and similarity of findings in the area of impervious surface thresholds on stream health described in Chapter 2, section C, part i of this report, the aquatic analysis of the three scenarios was ultimately based on the total impervious area percentage (TIA%) of each watershed in the Upper Etowah Region. The intent was to identify the number of low intensity and medium intensity development watersheds in which the TIA% is maintained below the permitted threshold. See Table 3 for the TIA% limitations per watershed district. Identifying the average TIA% per high and medium-high priority watershed is also worthwhile in assessing the aquatic impacts of these scenarios. These analyses were completed on each of the 84 HUCs within each scenario to ascertain whether or not the development pattern and intensity reflected in each scenario would have an effect on the stream health of each watershed. The methods and results follow.

A GIS was used throughout this analysis. ArcView 3.2 was unable to process shapefiles of this size, therefore the shapefiles were converted to ArcInfo coverages to expedite processing. The first step in this analysis was to simplify each scenario. Planners within the Upper Etowah Region originally used over 50 different land use classifications. Some of these classifications were very specific, such as the 1-unit per acre residential designation in Forsyth County. However, some of these classifications were very general, such as residential in Lumpkin County. The eight different residential classifications within the entire region were reclassified as either low, medium, high or multi-family residential.

Creating the alternative scenarios introduced six new land use classifications. These included steep slopes, 75-foot stream and lake buffers, wetlands, township and rural zones. These six classes were combined with the 26 simplified original classes to produce a final list of 32 future land use classes. Table 6 lists the 32 classes and the build-out scenarios in which they apply.

Once the build-out scenarios were simplified, they were corrected by burning in the built elements of the 1998 land cover (transportation, low-intensity and high-intensity urban classes). This process accounted for the existing impervious surfaces within the Upper Etowah Region and significantly improved the accuracy of this assessment. Each of the scenarios then had existing and future land use categories.

Once these scenarios were corrected, each of the land use classes was assigned an impervious surface coefficient. The impervious surface coefficient for low-intensity urban, high-intensity urban and transportation were 0.23, 0.46 and 1.0, respectively. The basis for these assignments is discussed in Chapter 2, section C, part iv. The 32 future land use classes were assigned a percent impervious surface based either on literature review or through estimates by the researcher. Table 6 lists all the land use classes, including the future and existing classes, the impervious surface coefficient per class and the origin of each estimate.

Impervious Surface Estimates

As illustrated in Table 6, many of the land use classes did not have a published impervious surface coefficient and an estimate by the author had to be made. In all of these classes, except Conservation and Trout Buffer, the estimates were based on published percentages from similar classes. In other words, all the significant natural areas (Wetlands, Slopes 25%, Buffers) were given an impervious surface coefficient of 0.019, equivalent to the published Agriculture value. Since development is either prohibited or unlikely in each of these significant natural areas, depending upon the scenario, and Agriculture had the lowest published value, the impervious surface coefficient for the Agriculture class was selected for all the significant natural areas.

The Conservation and Trout Buffer classes were given an even lower impervious surface coefficient because the author believed that they would, on average, have less impervious surface than the significant natural areas. In the Conservation class instance, this assumption was made because local governments designated these areas for conservation purposes, meaning that they would have long-term protection as forest cover. It was assumed that a forest patch would generally have less impervious surface than an agriculture tract of land.

The Trout Buffer was also assigned an impervious surface coefficient of 0.01. This assumption was based on the fact that these buffers are located in areas of steeper topography, and are therefore less likely to be developed. Changes to Georgia's Erosion and Sedimentation Control Act in 2000 also made the criteria for receiving a variance to develop within the trout buffer more stringent. This measure contributed to the reduction of the impervious surface coefficient of the Trout Buffer class below the Agriculture and significant natural area classes.

The Rural Zone estimate was based in part on the percent impervious value of the 2-acre Lot Residential class published by Cappiella and Brown (2001). This impervious surface coefficient is 0.106. A simple conversion of this value to a 10-acre lot residential value (equivalent to a Rural Zone) would require dividing by 5 (magnitude difference between 2 and 10 acres). This would provide a Rural Zone impervious surface coefficient of 0.021. This value was increased to 0.040 to account for the additional road infrastructure needed to serve a home on a 10-acre lot versus a home on a 2-acre lot.

The Planned Unit Development, Transition, Activity, Village, and Township Zone classes were assigned the same impervious surface coefficient as the Residential

High class. Each of these classes is described in the comprehensive land use plans as mixed-used developments that combine housing, office and shopping spaces. Essentially, these classes are identical. The 0.278 value is based on the land use category of four units per acre (Cappiella and Brown, 2001). None of the cities in the Upper Etowah Region are likely to be dominated by multi-family housing; in fact, the most likely mixed-use housing density is four units per acre. Therefore, the 0.278 impervious surface coefficient was used for all the classes that are based on mixed-uses.

The final estimate of the impervious surface coefficient for each land use class is for the City class. Again, because cities within this region will be primarily dominated by business and road infrastructure and high-density residential development, rather than office and apartment towers, an impervious surface coefficient of 0.326 was assumed. This value corresponds to the value for eight units per acre in the Cappiella and Brown (2001) study.

Calculation of Percent TIA

After an impervious surface coefficient was assigned to each of the land use classes, the next step was to calculate the percent TIA per HUC. This was done simply through the attribute table of each of the scenario's coverages. Total acres per shape were calculated by multiplying the number of shapes by 0.0002471044, the conversion ratio of m^2 to acres. The total acres of each shape were then multiplied by the impervious surface coefficient of that shape to calculate the total number of impervious acres per shape. The total and impervious acres of the lakes shapes were calculated to zero, since they neither contribute to runoff nor are developable.

Table 6. Land use classes used for the three build-out scenarios, the scenarios in which they apply, the percent impervious surface per class and the origin of the percent impervious surface calculation.

Class	Scenario(s)	Impervious Surface Coefficient	Coefficient Origin
Agriculture	Plan, Alt I	0.019	Cappiella and Brown, 2001
Activity	Plan, Alt I	0.278	Author Estimate[1]
City	Plan, Alt I	0.326	Author Estimate[1]
Conservation	Plan, Alt I	0.010	Author Estimate[1]
Commercial	Plan, Alt I	0.722	Cappiella and Brown, 2001
Forest/Agriculture	Plan, Alt I	0.019	Author Estimate[1]
Forsyth Stream Buffer	Plan, Alt I	0.019	Author Estimate[1]
Government	Plan, Alt I	0.344	Cappiella and Brown, 2001
Industrial	Plan, Alt I	0.534	Cappiella and Brown, 2001
Lakes	Plan, Alt I, Alt II	0.000	Author Estimate[1]
Lake Allatoona Buffer	Plan, Alt I	0.019	Author Estimate[1]
Lake Buffer 25'	Plan	0.019	Author Estimate[1]
Lake Buffer 75'	Alt I, Alt II	0.019	Author Estimate[1]
Low-intensity Urban	Plan, Alt I, Alt II	0.230	Institute of Ecology[2]
High-intensity Urban	Plan, Alt I, Alt II	0.460	Institute of Ecology[2]
Parks/Recreation	Plan, Alt I	0.086	Cappiella and Brown, 2001
Planned Unit Development	Plan, Alt I	0.278	Author Estimate[1]
Residential High	Plan, Alt I	0.278	Cappiella and Brown, 2001
Residential Low	Plan, Alt I	0.143	Cappiella and Brown, 2001
Residential Medium	Plan, Alt I	0.212	Cappiella and Brown, 2001
Residential Multi	Plan, Alt I	0.444	Cappiella and Brown, 2001
River Corridor Buffer	Plan, Alt I, Alt II	0.019	Author Estimate[1]
Rural Zone	Alt II	0.040	Author Estimate[1]
Slopes >25%	Alt I, Alt II	0.019	Author Estimate[1]
Stream Buffer 25'	Plan	0.019	Author Estimate[1]
Township Zone	Alt II	0.278	Author Estimate[1]
Transition	Plan, Alt I	0.278	Author Estimate[1]
Transportation	Plan, Alt I, Alt II	1.000	Institute of Ecology[2]
Trout Buffer	Plan, Alt I	1.000	Author Estimate[1]
Village	Plan, Alt I	27.8	Author Estimate[1]
Water supply Buffer	Plan, Alt I, Alt II	1.9	Author Estimate[1]
Wetlands	Alt II	1.9	Author Estimate[1]

[1]Estimate made by the author based upon impervious surface coefficient values for similar land use classes published in Cappiella and Brown, 2001.
[2]Impervious surface coefficient calculated as part of the Etowah River Habitat Conservation Plan at the University of Georgia, Institute of Ecology; unpublished.

The percent impervious surface per HUC was calculated simply by summing the total acres and impervious acres of all the shapes within each HUC and dividing the total impervious acres by the total acres.

Percent TIA Results

Seven of the 84 HUCs are classified as a high protection priority. These watersheds are the most important to the overall aquatic integrity of the Upper Etowah Region because they either provide exceptional habitat for imperiled species or significantly contribute to the mainstem of the Etowah River. All three of the build-out scenarios moderately to highly protect these seven HUCs. Both of the alternative scenarios kept the TIA below ten percent at build-out for each of these HUCs. The Alternative I and II Scenarios had an average percent TIA of 6.4 and 5.87 for these seven HUCs, respectively.

Only two of the HUCs in the Planned Scenario exceeded the 10% TIA threshold at build-out, Shoal Creek in Dawson County (HUC 031501040104) and the Etowah River mainstem, roughly between the Chattahoochee National Forest and Castleberry Bridge Road (HUC 031501040106). The TIA of Shoal Creek and this section of the Etowah mainstem was 11.6% and 11.3%, respectively. The average TIA for the seven high priority watersheds in the Planned Scenario at build-out is 9.33%. Table 7 illustrates the percent TIA for each of the high priority watersheds, within each of the build-out scenarios.

Note that many of these HUCs lie within the Chattahoochee National Forest or Dawson Forest. The percent TIA was calculated solely from the counties' future land use maps, not state or federal management plans. Therefore, if part of the HUC was mapped as residential low density by the county, but is managed as Dawson Forest Wildlife Management Area, the county's designation is honored.

Table 7. Percent TIA for High Priority HUCs.

HUC	Waterbody	Location	1998	Plan	Alt.I	Alt.II
031501040103	Etowah River	National Forest	1.9	5.9	3.9	4.7
031501040104	Etowah River	N. Forest to Castleberry Bridge	2.8	11.6	7.9	6.2
031501040106	Shoal Creek	Dawson County	2.9	11.3	8.8	7.6
031501040201	Amicalola River	Headwaters	1.9	9.5	4.9	4.7
031501040202	Little Amicalola	Dawson County	2.7	8.9	5.7	5.8
031501040203	Cochran Creek	Dawson County	2.8	8.7	6.1	6.1
031501040204	Amicalola River	Confluence with Etowah River	2.6	9.4	7.5	6.0

Twenty-one of the remaining HUCs are classified as medium-high priorities. These HUCs are combinations of subwatersheds that were classified as either high, medium-high or medium-low priority tributary systems for the Habitat Conservation Plan. These HUCs are drained by either Shoal Creek in Cherokee County, Long Swamp Creek, Sharp Mountain Creek or small, isolated creeks that discharge directly to the mainstem of the Etowah River. Note that the HUCs include the mainstem of the river. The Habitat Conservation Plan included the entire mainstem of the Etowah River as a high protection priority. Because sections of the mainstem of the Etowah River are nested within each HUC, and the protection priority of each HUC is an average of the protection priority of all the subwatersheds that form it, much of the mainstem of the Etowah River is considered a medium-high priority rather than a high priority.

Of these 21 HUCs, only five have a TIA less than 10% in the Planned Scenario. The Alternative I and II Scenarios limit the TIA to less than 10% in eight and 14 of these 21 HUCs at build-out, respectively. Table 8 illustrates the percent TIA at build-out for these 21 HUCs.

Table 8. Percent TIA for the Medium Priority HUCs.

HUC*	Waterbody	Location	1998	Plan	Alt.I	Alt.II
105	Etowah River	Castleberry to Seed Tick Rd.	2.5	11.9	8.9	5.9
107	Etowah River	Seed Tick to Shoal Creek	4.9	13.2	11.5	8.2
301	Etowah River	Shoal Creek to Settingdown Creek	2.2	7.4	4.7	5.6
306	Etowah River	Settingdown to Long Swamp Ck.	2.9	7.9	6.0	6.4
401	Pendley Creek	Headwater to Cove Road	6.7	14.8	13.3	10.3
402	Cove Creek	Cove Road to Cox Road	3.8	12.9	11.8	8.3
403	Long Swamp Creek	Cox Creek to Old Nelson Rd.	6.9	14.4	12.4	9.6
404	Long Swamp Creek	Old Nelson Rd. to Etowah River	3.6	11.5	10.5	6.3
501	Padgett Creek	HW 53 to Sharp Mountain Creek	8.6	27.0	25.9	11.9
502	Sharp Mountain Creek	Headwater to Rock Creek	6.0	18.1	17.4	10.4
503	Rock Creek	Headwater to Sharp Mountain	2.6	7.4	7.4	5.9
504	Bluff Creek	Headwater to Sharp Mountain	3.8	8.6	6.1	7.3
505	Sharp Mountain Creek	Rock Creek to Bluff Creek	6.6	20.9	19.9	10.6
506	Sharp Mountain Creek	Bluff Creek to Etowah River	6.2	19.9	17.7	10.4
601	Etowah River	Long Swamp to Sharp Mountain	4.9	11.7	9.4	8.9
602	Etowah River	Sharp Mountain to Edward Creek	6.0	30.1	28.3	9.2
603	Etowah River	Edward Creek to City of Canton	7.8	26.6	24.4	12.0
605	Etowah River	City of Canton to Shoal Creek	7.3	24.8	23.5	11.6
701	Shoal Creek (Cherokee)	Headwater to Cable Road	3.5	10.8	9.1	7.7
702	McCanless Creek	Headwater to Shoal Creek	4.1	12.8	10.6	7.4
704	Shoal Creek (Cherokee)	McCanless Creek to Etowah River	2.2	7.5	5.5	5.5

*All HUCs have the same first nine digits: 031501040

Another method of analyzing these data is to assess the number of HUCs per scenario that stayed within the TIA thresholds established under the Watershed Protection Districts (Table 3). The low intensity districts are the most critical HUCs because of their high protection priority or because they have a very low existing amount of impervious surface (0-5%). The TIA threshold for these HUCs is 10%. The medium intensity districts are composed of medium protection priority HUCs or HUCs with no aquatic habitat data that have an existing impervious surface between 6-25%. The TIA threshold for these HUCs is 25%. The HUCs in the high intensity districts have no TIA threshold because they are not protection priorities.

Of the 46 HUCs in the low intensity districts, only 16 in the Planned Scenario remained under the 10% threshold. In the Alternative I Scenario, 27 of the 46 HUCs remained under this threshold. Finally, in the Alternative II Scenario, 39 of the 46 HUCs remained under this threshold. The seven HUCs that exceeded the 10% threshold at the build-out of the Alternative II Scenario are listed in Table 9. The remaining data from this analysis are located in Appendix I.

Table 9. The seven low-intensity district HUCs exceeding 10% TIA in the Alternative II Scenario.

HUC*	Waterbody	Location	1998	Plan	Alt.I	Alt.II
501	Padgett Creek	HW 53 to Sharp Mountain Creek	8.6	27.0	25.9	11.9
502	Sharp Mountain Creek	Headwater to Rock Creek	6.0	18.1	17.4	10.4
505	Sharp Mountain Creek	Rock Creek to Bluff Creek	6.6	20.9	19.9	10.6
506	Sharp Mountain Creek	Bluff Creek to Etowah River	6.2	19.9	17.7	10.4
603	Etowah River	Edward Creek to City of Canton	7.8	26.6	24.4	12.0
605	Etowah River	City of Canton to Shoal Creek	7.3	24.8	23.5	11.6
703	Lake Arrowhead	Headwaters to Shoal Creek	9.3	26.0	20.4	11.5

*All HUCs have the same first nine digits: 031501040

The last form of aquatic impact analysis is the number of HUCs that exceeded the 25% TIA for the medium intensity district. Of the 26 HUCs that were classified as medium intensity districts, 18 had a TIA of less than 25% at planned build-out. In the Alternative I Scenario, 20 of the 26 had a TIA of less than 25% at build-out. Finally, the Alternative II Scenario kept all 26 of the medium intensity districts at less than 25% TIA at build-out.

Rural Character Impact

The majority of the Upper Etowah Region is characterized by rolling forested hills, chicken houses and pasture. In fact, 1998 LandSat TM land cover illustrates that over 85% of the region is in forest cover (70.7%), agriculture (10.1%) or is dominated by sparse vegetation (4.9%) (NARSAL, 2000). Forest cover provides habitat for wildlife, timber for the construction industry, reduces soil loss, cleans air, provides shade and recreational opportunities, has low maintenance costs and is visually attractive. Agriculture generates more revenue than any other industry in rural counties such as Dawson and Lumpkin. Corn is the most common crop and broilers are the most common livestock found in the Upper Etowah Region (Boatright and Bachtel, 2000). Sparse vegetation is a transitional vegetation state. Old farm fields that are succeeding to forest or timber harvests that are regenerating are also common to this region. The rural character of this region is not defined by any single land use, but rather includes all the non-urban land uses described here.

The pattern and intensity of the built landscape can ruin the rural character of a region. Strip mall shopping centers replace farmland, forests are clearcut for subdivisions and old fields are lost in areas that are rapidly developing in a low-density pattern. Country roads are widened and new roads are constructed to accommodate the impending population growth. A network of congested subdivision collector roads is a drastic departure from the charming country roads that dominate rural areas.

Local governments in the Upper Etowah Region are proud of their rural heritage. The loss of farmland and open space is a concern that they all share (Georgia Mountains Regional Development Center, 1994; Forsyth County Georgia Greenspace Program Grant Application, 2000; Cherokee County Greenspace Report, undated; Weitz, 2001; Pickens County Community Greenspace Program Application Report, 2002). This project will demonstrate the loss of open space and farmland that can be expected from the three scenarios.

Methods for Assessing the Loss of Rural Character

Since rural character is defined by a predominance of forested and agriculture land covers, the loss of these land covers will be used as the metric in assessing the loss of rural character resulting from the build-out of the three scenarios. A baseline of rural acres was calculated for each county to use as a gauge in determining rural acreage loss.

The baseline rural acreage per county was calculated with a GIS. The total land acres per county were calculated by subtracting the lakes coverage from each county coverage. The total acreage of roads and low-intensity and high-intensity development, obtained from the 1998 LandSat TM land cover, were then subtracted from the total land acres per county. The land cover of the resulting coverage consisted of nine classes, including three forested classes and one class of each of the following: wetlands, agriculture, sparse vegetation, mines, quarries and beaches. Mines, quarries and beaches composed less than 1%, cumulatively, of the coverage. All nine of these classes were considered rural land covers. The baseline rural acres per county is illustrated in Table 11.

The methods for calculating the rural acres at the Planned and Alternative I build-out involved selecting the appropriate polygons from the coverages created during the aquatic impact analysis. Table 10 lists the land cover classes that were considered rural in the Planned and Alternative I Scenarios. These land cover classes were selected within each coverage and converted to a shapefile. The polygons within each county were then selected and the areas were summed to derive the total rural acreage per county at build-out. Table 11 lists the total rural acerage at Planned and Alternative I build-out.

The methods for calculating the total rural acres of the Alternative II Scenario were identical except that the land cover classes varied. Table 10 also lists the land cover classes that were used in the Alternative II Scenario. The rural class that was created here is a zone that allows one dwelling unit per ten acres. Although this is a residential zone, the density is so low that it maintains the rural character of the area.

Table 10. Rural land use classes used for the calculation of

Class	Scenario(s)
Agriculture	Planned, Alternative I
Conservation	Planned, Alternative I
Forest/Agriculture	Planned, Alternative I
Forsyth Stream Buffer	Planned, Alternative I
Lake Allatoona Buffer	Planned, Alternative I
Lake Buffer 25'	Planned
Lake Buffer 75'	Alternative I, Alternative II
River Corridor Buffer	Planned, Alternative I, Alternative II
Slopes χ25%	Alternative I, Alternative II
Stream Buffer 25'	Planned
Rural	Alternative II
Trout Buffer	Planned, Alternative I
Water supply Buffer	Planned, Alternative I, Alternative II
Wetlands	Alternative II

<u>Rural Character Impact Results</u>

Table 11 illustrates the total rural acres of the region in 1998 and the total rural acres expected from each scenario in 2015. Comparing the 1998 scenario to the Planned Scenario suggests that 290,277 of the 786,476 rural acres will be converted to residential, commercial and other non-rural land cover classes by 2015. This translates to a 37% loss of the rural acreage in the region, in just a 17-year span (1998-2015). The greatest loss will be in Forsyth County, where only 21,980 acres (18%) of the original 118,957 rural acres will remain rural. The remaining counties have planned to maintain between 70-74% of their rural land as indicated on their future land use maps.

Protecting significant natural areas modestly reduced the amount of rural land loss. Over 520,000 of the 786,476 rural acres (67%) are maintained by incorporating the protection of significant natural areas into the future land use maps. The biggest gain of rural land protection occurs in Pickens County, the county with a significant amount of steeply sloped land that is currently unprotected. Total rural acreage protected for the region would increase by 5.2% simply by incorporating significant natural areas into each future land use map.

The Alternative II Scenario had a notable impact on the amount of rural land protected. Overall, 97% of the rural land in the entire Upper Etowah Region would be protected by instituting the rural zoning technique described in the Alternative II Scenario. Clearly, the scenario that clusters development into townships will protect the most rural acreage in this region.

Table 11. Existing and projected rural acres per county for each build-out scenario and the percentage of 1998 acres retained.

County	1998	Planned	Alternative I	Alternative II
Cherokee	228,627	161,190 (71%)	166,108 (73%)	217,589 (95%)
Forsyth	118,957	21,980 (18%)	27,962 (24%)	112,109 (94%)
Pickens	136,710	96,144 (70%)	103,256 (76%)	134,908 (99%)
Dawson	127,732	95,080 (74%)	100,143 (78%)	126,971 (99%)
Lumpkin	174,450	121,805 (70%)	131,506 (75%)	168,561 (97%)
TOTAL	786,476	496,199 (63%)	528,975 (67%)	760,138 (97%)

Economic Impacts

The composition and pattern of development has a fiscal impact on the government providing its service delivery systems. Service delivery systems are capital and human resources needed to deliver a service such as water, sewer, police protection, education and transportation (Duncan and Associates, 1989). Efficient development patterns that are compact, rely on existing service delivery infrastructure and mix uses have been found to be less costly than conventional, low-density, single-use, sprawl-like residential patterns. This finding was based on the following literature review.

Residential Land Use Does Not Pay for Itself

On average, residential land costs more in public services than it generates in tax revenue. The American Farmland Trust has completed 20 cost of community service studies throughout the Unites States demonstrating that residential development creates a net fiscal burden on local governments. Cost of community service studies compare the revenue to expenditure ratios of various land uses by comparing funds annually budgeted for each service delivery system to the revenues that each land use provides. The American Farmland Trust has found that on average, residential land has a $1.15:$1.00 cost to revenue ratio (American Farmland Trust, 2000). In other words, for every $1.00 of revenue gained by local governments from residential development, $1.15 in services are provided by that government. Revenue gains may include property and sales taxes, fees, forfeitures, and interest (Nelson, personal comment). The American Farmland Trust has found that there is a net loss to local governments by serving residential development.

Similar findings have been made in north Georgia. Although residential development generates more tax revenue than farm or forested land, the expense to service residential development generally outweighs any additional revenue. Dorfman et al. (2002) found a cost to revenue ratio of $1.60:$1.00 in Cherokee County for residential land uses. This study included the costs associated with schools, the greatest expense to local governments (Fodor, 1999). In Habersham County, Nelson and Dorfman (2000) found a cost to revenue ratio of \$1.23:\$1.00. This study did not include the costs of school construction, maintenance, operation or busing. Therefore, the disparity between cost and revenue would have been even greater had schools been included.

Two of the three largest annual expenditures budgeted by Habersham County are for a sheriff (public safety) and roads and bridges. The pattern of development may have an impact on the costs of these services. Compact development patterns produce less net road length and therefore, less patrolling area. The number of patrol officers and vehicles and the costs needed to operate and maintain a public safety department may be less for compact developments than for sprawling development patterns. Less net road length also translates to less road construction and maintenance. Compact development patterns should certainly have lower annual road maintenance and operation costs than sprawl-type development patterns.

Contrasting the cost to revenue ratio of residential development to the ratio of farm or forestland indicates a fiscal savings in maintaining rural land uses. Nelson and Dorfman (2000) found a cost to revenue ratio of \$0.70:\$1.00 for farmland, forest land and open space in Habersham County. Although rural land uses generate lower tax revenues than residential land uses, their considerably lower cost of service delivery systems translates into net savings. Development patterns that are dominated by rural land uses therefore should be more cost-effective than those that are dominated by residential land uses. The Alternative II Scenario is the only scenario that is dominated by rural land uses.

Commercial Development Subsidizes Residential Development

Local governments may seek commercial and industrial development to offset the revenue shortfalls resulting from residential development. The costs to service commercial and industrial developments are far less than the costs to service residential development. Robert Burchell found that office parks and industrial developments have the lowest cost to revenue ratios of any land use (Benfield et al., 1999). This finding was also documented by the American Farmland Trust (2000), that found commercial and industrial development had a $0.29:$1.00 cost to revenue ratio. Local governments recognize the revenue gains that commercial and industrial developments provide, and use temporary tax breaks and other incentives to lure these types of land uses.

Communities that effectively incorporate commercial land uses into residential areas may attract more commercial development than those that rigidly separate them. The Planned and Alternative I Scenarios limit the amount of commercial development by mapping their specific location. In most cases, these areas are not associated with moderately high-density residential development and are only accessible with an automobile. Limiting commercial development to specific areas and making it inaccessible to the non-driving community may hinder the development and success of commercial establishments.

In contrast, the Alternative II Scenario does not specifically map commercial development. This scenario directs commercial development to all townships, areas with moderately high-density residential development and that is pedestrian friendly. This greater degree of flexibility, in terms of the location of the commercial development, may attract more revenue generating commercial development to the region. Increased commercial development in the Alternative II Scenario will reduce any fiscal loss associated with residential development.

Clustered Communities are less Expensive

Clustered communities that contain a variety of housing types and retail establishments reduce the gap between public costs and revenues associated with residential development. The costs associated with transportation infrastructure (Virginia Beach Office of Planning, 1990), busing (Benfield et al., 1999; American Farmland Trust, 1998), solid waste collection and disposal (Duncan and Associates, 1989), public safety (Real Estate Research Corporation, 1974), and utilities (Virginia Beach Office of Planning, 1990) are all less expensive in communities that have compact versus scattered development. These costs are reduced primarily because areas that concentrate service areas have a smaller service delivery system.

Transportation Savings

The seminal cost of sprawl study was conducted in 1974 by Real Estate Research Corporation for the Council on Environmental Quality et al. Although this study is dated, and 1974 dollars are significantly different than 2003 dollars, the ratio of costs between low-density residential patterns and compact, mixed-residential patterns is still valid. The Real Estate Research Corporation (1974) found that planned mixed communities have considerably less capital transportation costs than low-density residential communities. In fact, these costs are 28.6% less for planned mixed communities. This study defined planned mixed communities as a 10,000-unit community composed of equal parts single family clustered, single-family conventional, townhouses, walk-up apartments, and high-rise apartments. A low-density community is defined as a 10,000-

unit community composed of 7,500 conventional single-family units and 2,500 clustered single-family units.

The cost savings associated with the reduction in road infrastructure between planned mixed communities and low-density residential communities were found to be even greater in a study prepared for the Virginia Beach Office of Planning (1990). In this study, the planned mixed scenario was found to have transportation cost estimates 51.9% less than the estimates for the low-density residential development scenario.

The reduction in transportation costs of planned mixed communities, evidenced in both of these studies, is due to the reduction in the lane miles of new roadway. Both the amount of local and collector roadway is expected to be less in these communities versus low-density communities. Planned mixed communities also combine land uses in a dense fashion, allowing trips like shopping and commuting to school to be accomplished by biking or walking. The total reduction in car trips will reduce traffic and congestion, lessening the need for road widening projects, and the compact arrangement of various land uses will reduce the need for additional new road construction.

The cost savings of roads in compact versus scattered communities are further evidenced in a study of the fiscal impacts of various development scenarios in Florida. Unlike the theoretical studies mentioned above, this empirical study examined the actual costs and revenues generated by existing developments in Florida. This study found that among the highest rate of return on road infrastructure was that of the contiguous, mixed-use community of Countryside, Florida. Over 90% of the costs incurred by this local government for the construction and maintenance of its road system were recovered by tax revenues. This contrasted significantly with the scattered development communities of Wellington and Cantonment that had road cost to revenue ratios of 56% and 39% respectively. Overall, this study suggests that 40-90% of the cost savings of compact and contiguous communities are from the reduction of road costs (Duncan and Associates, 1989).

Along with roads, the biggest cost to local governments are those associated with schools. In fact, over 80% of the costs to a local government are accounted for by schools and roads (Duncan and Associates, 1989). A single new classroom can cost $90,000 (Benfield et al., 1999). These high education costs translate to an annual education cost, per house, of $3,100 in Florida (Duncan and Associates, 1989). Robert Burchell found that the annual cost per house for schools in New Jersey was a staggering $11,377 (1990 dollars) (Benfield et al., 1999). These values are based on each school system's annual budget and the number of homes, school children and annual revenues derived from property taxes. The estimates of cost reductions associated with planned mixed communities are partially based on the reduction of the number of school children expected in high-density versus single-family housing. High-density housing is assumed to attract smaller families and more single adults, thus fewer school children. Fewer school children mean less school costs. Since the intent of the Alternative II Scenario is not to reduce single-family housing, but to cluster it with retail a variety of housing types, the estimates of school system savings attributed to apartment and townhouses are not documented here.

However, there is a significant cost reduction regarding public school systems in planned mixed communities, in terms of busing school children. The American Farmland Trust (1998) studied scattered communities near Chicago and found that clustering homes near schools reduced busing costs by 61.7-84.2%. A similar study in Loudoun County, Virginia found that busing costs for students living in 1-unit/acre developments was 5.5 times greater than the same number of units at a density of 4.5 units/acre (Benfield et al., 1999). Although school transportation costs may not be the largest component of school district spending, they are not trivial. Every 100 rural homes built provides an additional $6,800 to $12,500 a year in busing costs (American Farmland Trust, 1998).

The public cost of transporting solid waste is also reduced with planned mixed communities. The Real Estate Research Corporation (1974) found that 13.6% of the solid waste collection and disposal costs could be saved by the reduction in trip lengths between the hauling and disposal sites found in the planned mixed communities. Again, this scenario reduces these costs because residences are more clustered and therefore are easier and less time-consuming to service. This finding was consistent with that of Duncan and Associates (1989). In this study, Southpoint, a contiguous community characterized by mixed land uses and within 7.5 miles of downtown Jacksonville had the highest revenue to cost percentage for solid waste service. In this community, over 400% of the costs incurred by waste disposal were recovered through revenues. Only one of the scattered development communities profited from their solid waste service system. Wellington had a revenue to cost percentage of 130. The other scattered development community, Cantonment, actually spent more in hauling and disposing of trash than it recovered in curbside fees. Although solid waste may not be one of the greatest costs to local governments, considerable savings can be made by clustering residential development.

Public Safety

Next to roads and education, public safety is the second largest cost to local governments (Duncan and Associates, 1989). Southpoint, a community with a contiguous development pattern in Florida, had the highest percent return on fire/rescue and police services among 8 communities studied. While Southpoint's percent revenue to cost ratio was an astounding 525%, Wellington, a typical scattered, low-density residential community only had a percent revenue to cost ratio of 90%. In other words, Wellington lost 10 cents to every $1.00 invested in the public safety department while Southpoint made $5.25 for every $1.00 invested.

The correlation of high public safety costs to scattered, low-density development patterns was also found in the Real Estate Research Corporation (1974) study. In this case, planned mixed communities provided public safety services at costs that were 22.4% less than the same services in low-density developments. This study assumed that a single officer would occupy each patrol car. Therefore, the only variable affecting the total cost of services are the number of officers and patrol cars needed to service each community. Communities with less area require less patrol service and therefore produce less police protection costs. Fire protection is the other public safety service provided by most communities. Variables such as water supply, value of properties to be protected and population served were kept constant throughout this study. The only experimental variable was again, the service area.

Utilities

The final service delivery system analyzed here are utilities. Utilities include potable water, sanitary sewer, and stormwater systems. Without a doubt, the length of pipe, curb and gutter and other water and waste conveyance structures increases with the areal extent of the development pattern. Therefore, an increase in these costs is expected in communities that do not cluster development. This was the finding of both the Real Estate Research Corporation Study (1974) and the Virginia Beach Management Study (1990). The Real Estate Research Corporation Study found a cost savings of 40.6, 50.7 and 45.7% for the services of sanitary sewer, stormwater drainage and water supply, respectively, in the planned mixed community versus the low-density residential development pattern.

These cost savings were echoed in the Virginia Beach Management Study (1990) where the cumulative cost savings of developing in a planned mixed residential clustered pattern is estimated to be 43.4% more than the low-density development pattern. This estimate involved calculating the total length of pipe required per dwelling unit or per 1,000 square feet of gross floor area, and estimating the diameter and length of interceptors required to connect the entire growth area to the nearest sewage treatment plant. In neither the planned nor low-density development pattern case was a new wastewater treatment plant needed.

These estimates should ring true for the build-out scenarios in the Upper Etowah Region. Sewage treatment is currently limited in Lumpkin County to Dahlonega and Lumpkin County's comprehensive land use plan does not indicate the prospect of extending water or sewer outside this municipality. In Dawson County, a long-range water and sewer plan is just being started and will take over a year to complete (Cook, personal comment). Currently, water and sewer do not extend beyond the city of Dawsonville. In Pickens County, water and sewer lines are currently limited to the city of Jasper. A new wastewater treatment plant is being planned, but has not yet been sited (Vanden Bosch, personal comment (a)). Water and sewer lines generally run throughout the counties of Cherokee and Forsyth.

The Alternative II Scenario would not require the extension of any of these utilities outside the township areas. The rural areas, with their 1-unit/10 acre density, would not require governmental water or sewer infrastructure and could rely on wells and septic systems for potable water and waste disposal. Since most of these units would be on collector roads and would be predominately forested, the amount of stormwater infrastructure required would also be minimal. Although additional utility infrastructure will certainly be needed to serve the residents of the townships, the geographic extent of this infrastructure will be comparably small. As indicated in the above studies, it is the areal extent and total length of this infrastructure that dictates cost. Therefore, the Alternative II Scenario, with its smaller areal extent and greater overall density within developed areas, should be the most cost-effective scenario to service with public utilities.

Although most of the literature cited here is dated, the ratio of costs between the development patterns should still apply. The suburban development patterns referred to as low-density development have not changed since the 1940s, therefore their cost comparison to traditional development neighborhoods has also not significantly changed. This analysis clearly shows that development patterns that are compact, incorporate commercial land uses and mixed residential types are less expensive to service. With a single mile of new sewer line costing $200,000 and a mile of single lane road costing $4,000,000 in 1999 dollars (Benfield et al., 1999), the margin between a community service budget shortfall and surplus is miniscule. Build-out scenarios that restrict the extent of community services will reduce their costs and will more effectively meet conservative budgets.

Analysis Conclusion

The objective analysis of the three scenarios indicated that impacts to stream health, rural character and fiscal sustainability will be mitigated through the build-out of the Alternative II Scenario. At build-out, the Alternative I and II Scenarios will maintain TIA < 10% within all seven of the high priority watersheds in the Upper Etowah Region. Conversely, the Planned Scenario will not effectively protect stream health along the mainstem of the Etowah River from the Chattahoochee National Forest to Castleberry Bridge Road or in the Shoal Creek (Dawson County) watershed, two of these seven high priority watersheds. The Alternative II Scenario also maintains 39 (84.8%) of the 46 HUCs that compose the Low Intensity District below the 10% TIA threshold. On the other hand, the stream health of 19 (41.3%) of these 46 HUCs is expected to become degraded at Alternative I Scenario build-out.

The effect that each scenario will have on the rural character of the Upper Etowah Region is startling. Only 496,199 (63.1%) of the 786,476 rural acres of this region will be maintained as non-urban land at the Planned Scenario build-out. In 2015, over 1/3 of the existing rural land will be converted to an urban or suburban land cover class in this scenario. The Alternative I Scenario maintains slightly more rural acres (528,975 or 67.3%) at build-out. Still, a large proportion of the rural land that defines this region will be lost to commercial, industrial or some form of residential land by 2015 with the build-out of this scenario. The Alternative II Scenario, however, maintains the majority of the rural land cover of this region. In fact, 760,138 acres or 96.6% of the existing rural land will be maintained at the build-out of the Alternative II Scenario.

Studies in north Georgia and throughout the remainder of the United States show that, on average, residential properties provide a net fiscal burden to local governments. Although tax revenues are greater for residential properties than for agriculture or forested properties, the costs of the service delivery systems are so great for residential properties that a net fiscal loss occurs. Both the Planned Scenario and Alternative I Scenario have a considerable amount of land classified for residential development. In fact, 33.8% and 30.3% of the entire region is classified as residential land at build-out in the Planned and Alternative I Scenarios, respectively. Because the Alternative II Scenario clusters residential development into townships, the percentage of land classified as residential land is considerably less, just 4.3%. This scenario should translate into significant fiscal savings to local governments.

Although all three scenarios provide enough housing for the projected population of 622,793 by 2015, only the Alternative II Scenario will mitigate the impacts to stream health, rural character and public costs associated with the build-out of the Upper Etowah Region.

CHAPTER 4

MAJOR HURDLES TO IMPLEMENTING THE ALTERNATIVE II SCENARIO

Although the Alternative II Scenario mitigates the impacts of development on stream health, rural character and public costs, as compared to the Planned and Alternative I Scenario, debate may exist about whether or not the Alternative II Scenario is legal and desirable. In order for the Alternative II Scenario to be realized, local governments will have to downzone significant portions of each county. The use of overlay zones, especially for the protection of the significant natural areas described above, may also be needed. This section will discuss the case law associated with regulatory takings and the use of downzoning and overlay zones to protect public interests.

The Alternative II Scenario also includes the clustering of homes into moderately high-density townships. This concept is contrary to the conventional large lot, low-density housing pattern that dominates the housing market. The final section will highlight research related to the desirability and market for compact, mixed-use housing.

Is Downzoning Legal in Georgia?

Downzoning an area decreases the allowable density and use of the affected properties, as compared to the density and use allowed by the existing zoning ordinance. Local governments in other states have used this planning tool to protect the agricultural and environmental values of land. The Georgia Supreme Court, however, has never taken up the issue of downzoning (Smith, 2002). One is left to speculate whether Georgia courts would uphold downzoning as a viable planning tool and not consider it a regulatory takings of property.

Plaintiffs seeking relief from regulatory controls of property commonly claim a taking. Takings law derives from the U.S. and Georgia Constitutions that prohibit the taking of property without just compensation. In the opinion of the *Pennsylvania Coal Co. v. Mahon* (1922) case, Justice Oliver Wendall Holmes proclaimed: "The general rule at least is that while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a takings" (Zoeckler, 1997). This landmark case gave landowners the ability to pursue remedy for fiscal harm wrought by a regulation rather than just a physical taking of property.

There are two grounds for alleging a regulatory takings case in Georgia. First, the landowner must prove that the zoning presents a significant detriment (Smith, 2002). The loss of profits associated with the restriction of property, alone, does not constitute a significant detriment. This was the finding in *Parking Association of Georgia, Inc et al. v. City of Atlanta.* In this case, a provision of Atlanta's zoning ordinance requiring a minimum amount of landscaping and use of barrier curbs in parking lots with greater than 30 parking spaces was upheld. Although the maximum number of spaces per parking lot was reduced by this provision, a significant detriment to the landowner was not found.

A similar finding occurred in the Georgia case of *Town of Tyron et al. v. Tyrone, LLC, et al.* In this case, the plaintiff claimed that his property, as currently zoned, was worth significantly less than it would be if his variance request for a commercial rezoning had been approved. The court concluded, once again, that a change in economic value resulting from the action of a planning agency does not warrant a significant detriment. Regarding the Alternative II Scenario, these two cases suggest that although downzoning a property to a ten-acre lot density may restrict its use or cause an economic harm, alone, these findings do not constitute a significant detriment.

However, if a significant detriment is found, a plaintiff must then prove that the regulation in question has an insubstantial relationship with pubic welfare in order for an unconstitutional takings to be found (Smith, 2002). The opinion of *Parking Association of Georgia, Inc et al. v. City of Atlanta* clearly states that the concept of public welfare is broad and inclusive. In this case, the plaintiff failed to present clear and convincing evidence that the regulation in question was not substantially related to public health, safety, morality or aesthetics. Public welfare has also been held to include spiritual, physical and monetary values (Smith, 2002). Since Georgia courts define public welfare so broadly, they should generally favor the public good over the plaintiff's individual, economic burdens.

In the case of the Alternative II Scenario, the public benefit is clear and comprehensive. The downzoning of property has been shown in this study to protect stream health, maintain the land uses that constitute the rural character of the Upper Etowah Region and reduce the public costs expected from the build-out of the region. Additionally, downzoning in the Upper Etowah Region will help protect and sustain wildlife habitat, community health and safety (through flood control and water quality protection), recreational uses (hunting, fishing, paddling), aesthetics and quality of life (scenery, clean air and water), educational, scientific, and artistic resources and economic development (forestry, agriculture, sustainable residential and commercial growth). There is no doubt that the downzoning of portions of the Upper Etowah Region will meet the public welfare argument of Georgia's takings balancing test.

Other states have successfully used downzoning to protect rural areas. In 1980, Montgomery County, Maryland adopted a master plan that downzoned 91,591 (28%) of the county's 323,000 total acres. This downzoning reduced the density in the Rural Density Transfer Zone from a five-acre lot to a 25-acre lot in order to protect agricultural land. This regulatory action was contested in a Maryland circuit court and was found not to be a taking. The county had also established a transfer of development rights (TDR) program that provided economic relief to downzoned property owners by allowing them to transfer their development rights. Although this mechanism certainly strengthens the claim that downzoning does not cause an economic harm, the courts found that downzoning was legal on its own merits and did not constitute a taking, with or without a TDR (Pruetz, 1997).

If downzoning were found to be constitutional in Georgia, a landowner may still claim that the regulation is a taking under the U.S. Constitution. The first federal regulatory takings case occurred over 80 years ago and a two-pronged approach of analyzing each case has evolved (Zoeckler, 1997). These prongs are very similar to the two tests that Georgia courts require when arguing a regulatory taking. The first prong tests whether or not the regulation in question "substantially advances legitimate state interests". This is very similar to the "insubstantial relationship" rule for arguing a taking under the Georgia Constitution. Zoning regulations that protect legitimate state interests, such as public safety, and environmental or historic areas routinely meet this prong of the test as long as the regulation was properly drafted (Zoeckler, 1997). The public benefits of downzoning portions of the Upper Etowah Region, as outlined above, should meet this part of the test.

The second prong identifies whether the regulation deprives the owner of all (or nearly all) of his or her "economically viable use of the property". As in the Georgia test, mere diminution of value, alone, is never sufficient to meet this prong and establish a taking (Zoeckler, 1997). While courts will consider an economic valuation of the property pre- and post-regulation, an emphasis is placed on the residual value of the parcel as a whole, rather than the loss in economic value or the economically viable use of a segment of the property. Only if virtually no economic value of the *entire* property remains after the regulation will a federal taking be found (Zoeckler, 1997).

In an analysis related to the "economically viable use of property" test, federal courts will ascertain whether a regulation interferes with the landowner's "distinct investment-backed expectation". This test is similar to the concept known as "vested rights" in Georgia. In both the federal and state courts, the claimant may elect to cite the loss in economic expectations of property as evidence towards a taking. Evidence may include the submission of an application for a development permit, the execution of a contract for architectural design work or a lending institution's approval for a loan. Relatively speaking, vested rights are much easier to prove in Georgia courts than in federal courts (Zoeckler, 1997). In other words, while the examples outlined above may constitute a "vested right" in property in Georgia courts and favor the claimant's argument for a "significant detriment", it probably will not qualify as an "investment-backed expectation" under the U.S. Constitutions Fifth Amendment.

The analysis of the case law and multi-pronged approaches described above shed a favorable light on the use of downzoning in Georgia to protect the needs of the public over the economic wishes of the individual. However, the fact that the Georgia courts have never addressed the issue warrants caution in pursuing this approach as a conservation tool in the Upper Etowah Region.

<u>Are Overlay Zones Legal in Georgia?</u>

Overlay zones supplement underlying zoning codes with additional requirements. Thus, a parcel of land within an overlay zone is subject to two sets of regulations (Bose, 2002). Overlay zones are used throughout the U.S. and in Georgia to encourage or discourage certain types of development and to preserve certain areas, such as historic districts or significant environmental areas. Forsyth County uses overlay zones to denote the areas protected by the environmental planning criteria established under the Georgia Planning Act.

As mentioned earlier, exclusive power to engage in zoning and planning is vested by the Georgia Constitution to the counties and municipalities of Georgia (Georgia Constitution, Article 9, Section 2). In other words, no state enabling legislation is needed for local governments in the Upper Etowah Region to use overlay zones to protect significant natural areas.

Although the Georgia General Assembly can enact laws that regulate procedural aspects of planning and zoning, the assembly's powers do not stipulate the type of zoning that is permitted. Therefore, the state of Georgia in no way limits the use, extent or purpose of overlay zones by local governments.

The only unique requirement for the adoption of overlay zones is that underlying zoning already exists. Lumpkin County is the only county in the Upper Etowah Region that has not adopted zoning regulations. Therefore, the use of an overlay zone in Lumpkin County would be contingent upon this county adopting a zoning ordinance. Local ordinances that protect significant natural areas can also be adopted that are irrespective of zoning. These stand-alone ordinances can be as protective as regulations imposed through the use of traditional or overlay zones. Appendix II contains a model overlay zoning ordinance to protect the significant natural areas described above.

Do Consumers Prefer Clustered Neighborhoods?

The final constraint to the implementation of the Alternative II Scenario is the uncertainty of the mixed-use, clustered housing market in the Upper Etowah Region. Mixed-use, clustered homes would define each township in this scenario.

One neighborhood concept containing mixed uses is new urbanism. New urbanism seeks to integrate the components of modern life - housing, workplace, shopping, and recreation - into compact, pedestrian-friendly, mixed-use neighborhoods (Eppli and Tu, 2000). This planning approach is relatively new and little market research has been conducted to identify its success, and the appropriate lot sizes, product mixes and base prices needed to maximize its prosperity (Fulton, 1996). The small amount of research conducted thus far shows mixed results.

New urbanism communities have been shown to sell faster and for more than suburban developments (Calthrope, 2000). Eppli and Tu (2000) found that homebuyers were willing to pay a $20,000 premium for properties in new urbanism communities compared to surrounding conventional neighborhoods. Regression analysis was used in this study to explicitly account for the property-by-property differences in construction quality, property age, and interior and exterior housing attributes between homes in new urbanism communities and homes in conventional neighborhoods. Property values have also tripled in just ten years in Seaside, Florida's pioneer new urbanism community (Fader, 2000). The interest in new urbanism has also grown tremendously. The number of new urbanism projects almost doubled (102 to 201) from 1996 to 1998 (Eppli and Tu, 2000).

Although these studies suggest that some local housing markets embrace new urbanism, it may be too early to tell if this neighborhood concept will become a housing market force nationwide. Lenders may be hesitant to finance new urbanism developments. New urbanism is a new, relatively untested housing concept and lenders may perceive it to be too risky to finance. Lenders prefer funding project types with a strong track record, financial capacity and proven experience - features new urbanism cannot deliver (Fulton, 1996). Builders also may be reluctant to institute new urbanism features because of the uncertain market expectations (Fader, 2000). The costs associated with extensive planning, development delays and the construction of civic structures and public amenities has made the cost of homes in the new urbanism community of Kentlands 30% more per square foot than comparable homes in nearby conventional homes. This coupled with the inability to attract retail stores led to an overall sales lag (Fulton, 1996).

While it is too early to tell if new urbanism communities will be the wave of the housing future, in-town mixed-use communities are currently becoming a staple in the Atlanta housing market. Communities such as The Lofts at Market Village in Smyrna, Milton Park in Alpharetta and Metropolis in Atlanta are all designed with the walker in mind. These developments are within walking distance of greenspace, restaurants, or shops and combine a variety of housing types (Cauley, 2002). The mixed-use project attracting the most attention in Atlanta is Atlantic Station. This brownfield redevelopment includes parks, lakes, 3,200 residential units, four to five million square feet of office space, four hotels with 1,000 rooms and 1.5 million square feet of space for shopping and entertainment (Benfield et al., 2001). With over 4,200 residential units described here alone, in-town mixed-use communities are beginning to make an impact in the Atlanta housing market.

Although the concept of clustered, mixed-use housing in the form of new urbanism neighborhoods has become more popular across the country and Atlanta is quickly becoming the new millennium's national example of in-town mixed-use living, these successes may have very little impact on the housing market of the Upper Etowah Region. Many homebuyers move to the Upper Etowah Region to escape Atlanta and welcome the comparable low-cost of living and lack of congestion that much of this region offers.

In the Upper Etowah Region, the housing market rules of inexpensive land and few public amenities still hush the concepts of town centers, commercial uses and pedestrian infrastructure that clustered, mixed-use developments promise. The concepts of large lots and nice views are still more customary than community-oriented development in today's housing market of the Upper Etowah Region. This market will have to change in order for the township concept of the Alternative II Scenario to succeed. Without the clustering of residential land into townships, the benefits that the Alternative II Scenario holds will not be realized.

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FIGURES

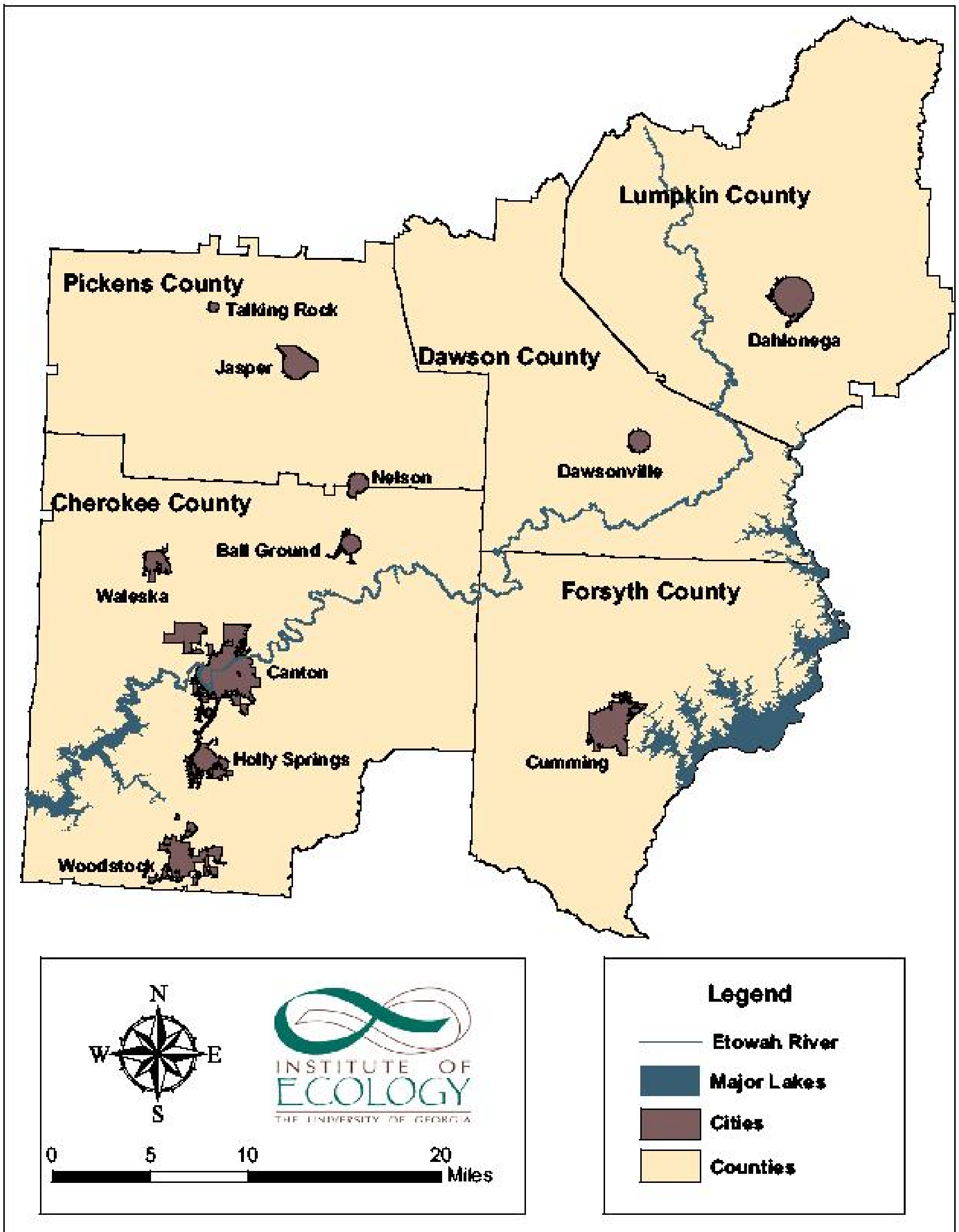


Figure 1. The counties and municipalities of the Upper Etowah Region.

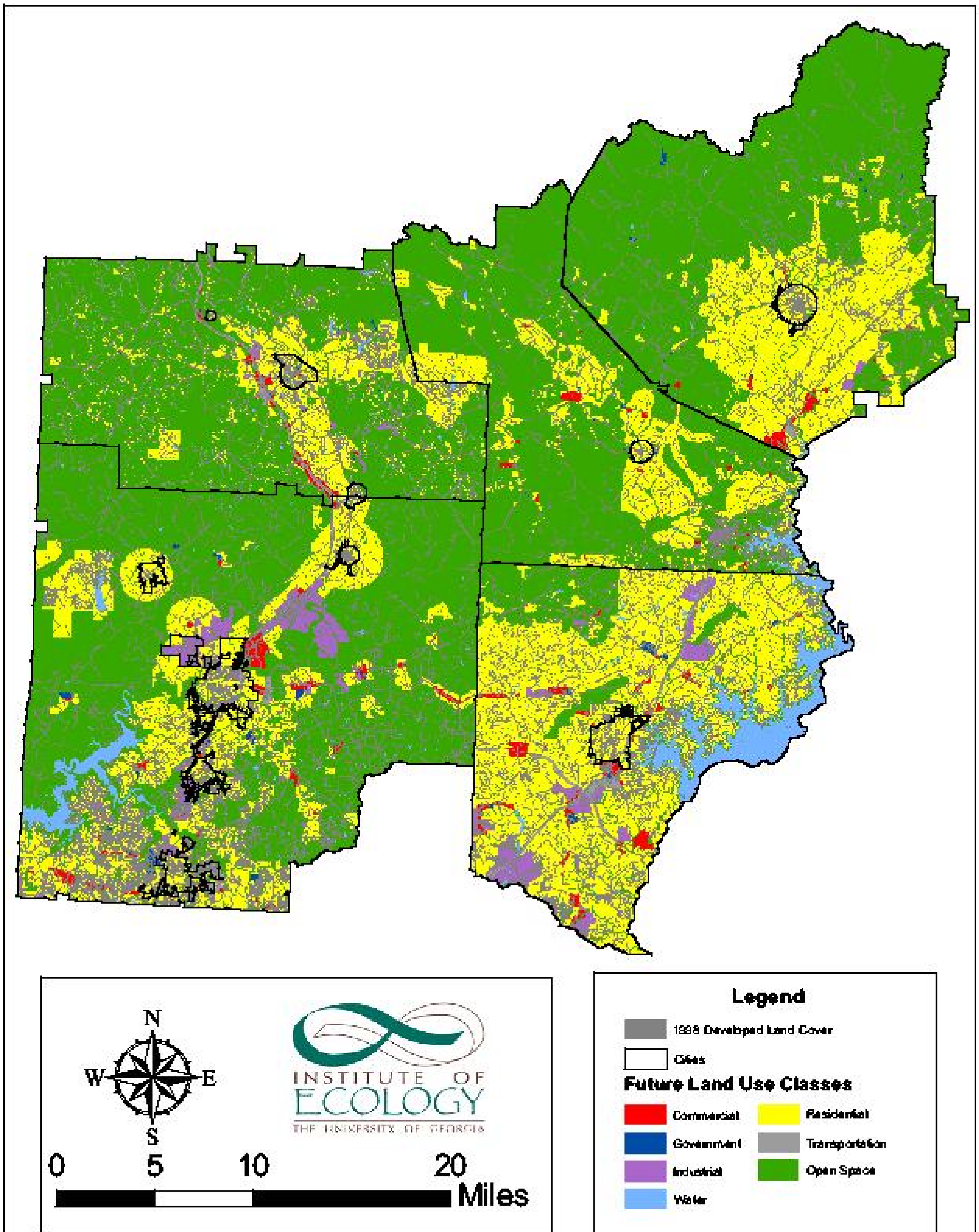


Figure 2. Simplified Planned Build-out Scenario.

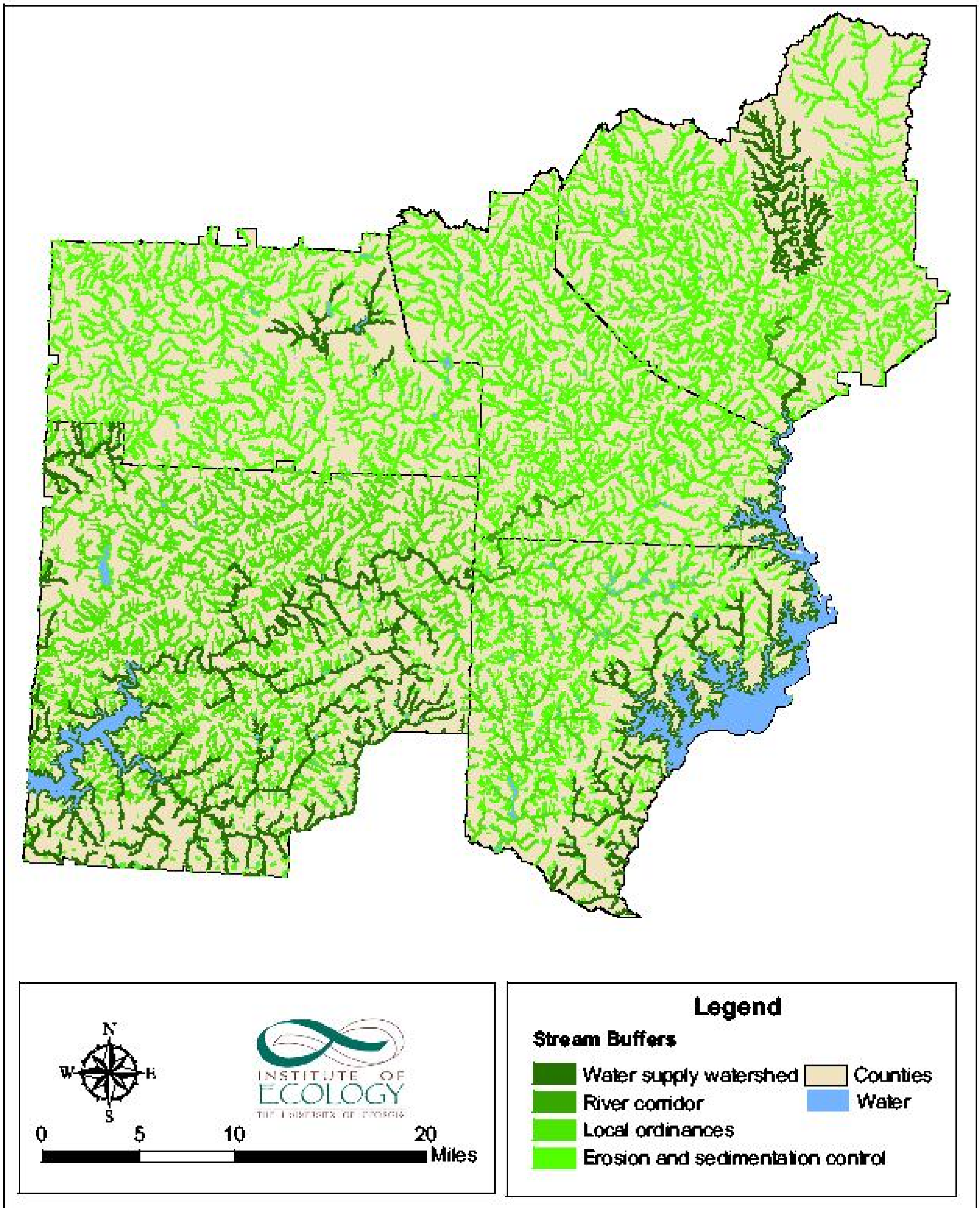


Figure 3. Protected stream buffers throughout the Upper Etowah Region.

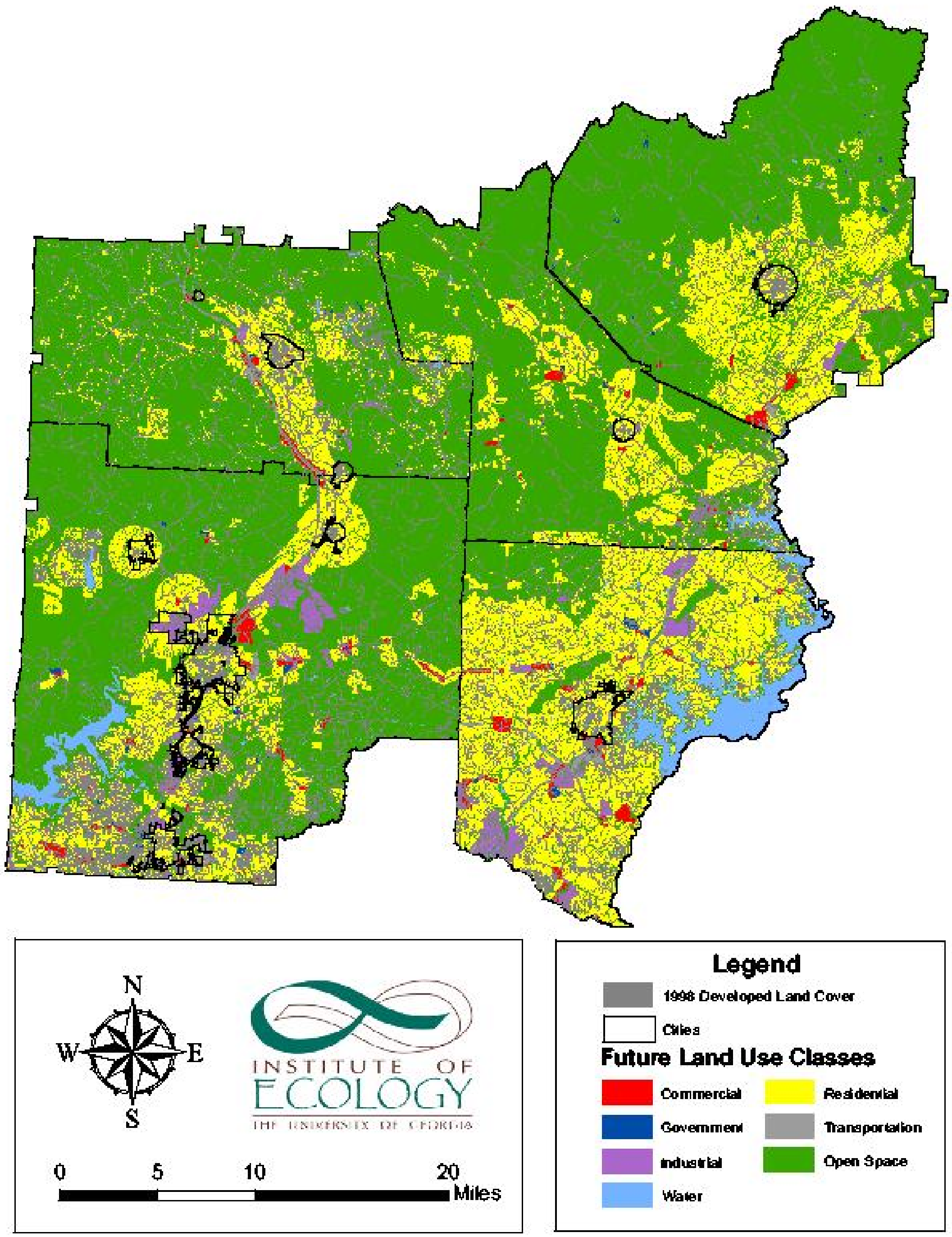


Figure 4. Simplified Alternative I Build-out Scenario.

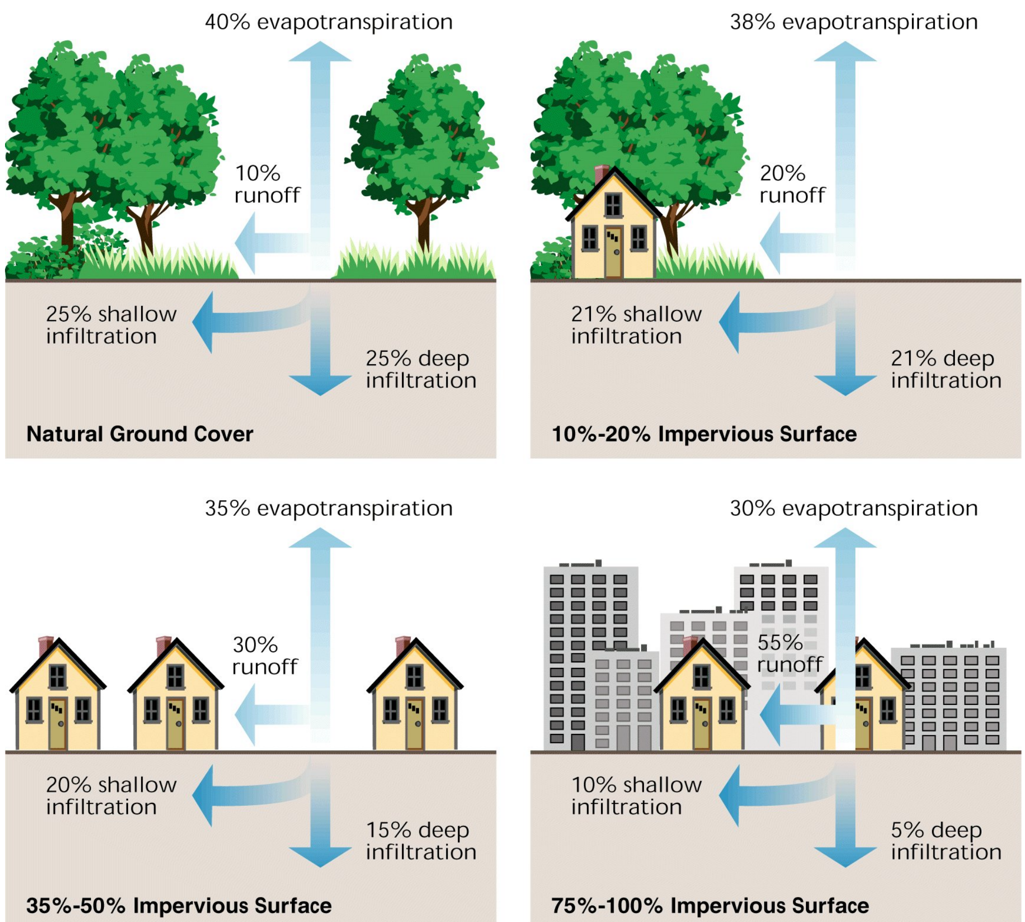


Figure 5. Effects of varying amounts of impervious surface on the water cycle. Source: Federal Interagency Stream Restoration Working Group, 1998.

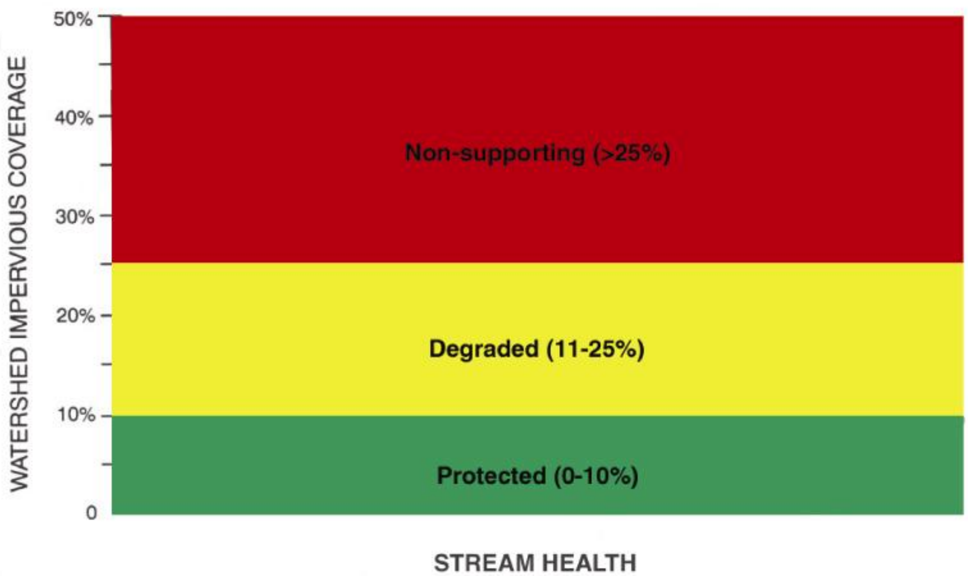


Figure 6. Stylized relationship between percent watershed imperviousness and stream health. Source: Center for Watershed Protection, 1996.

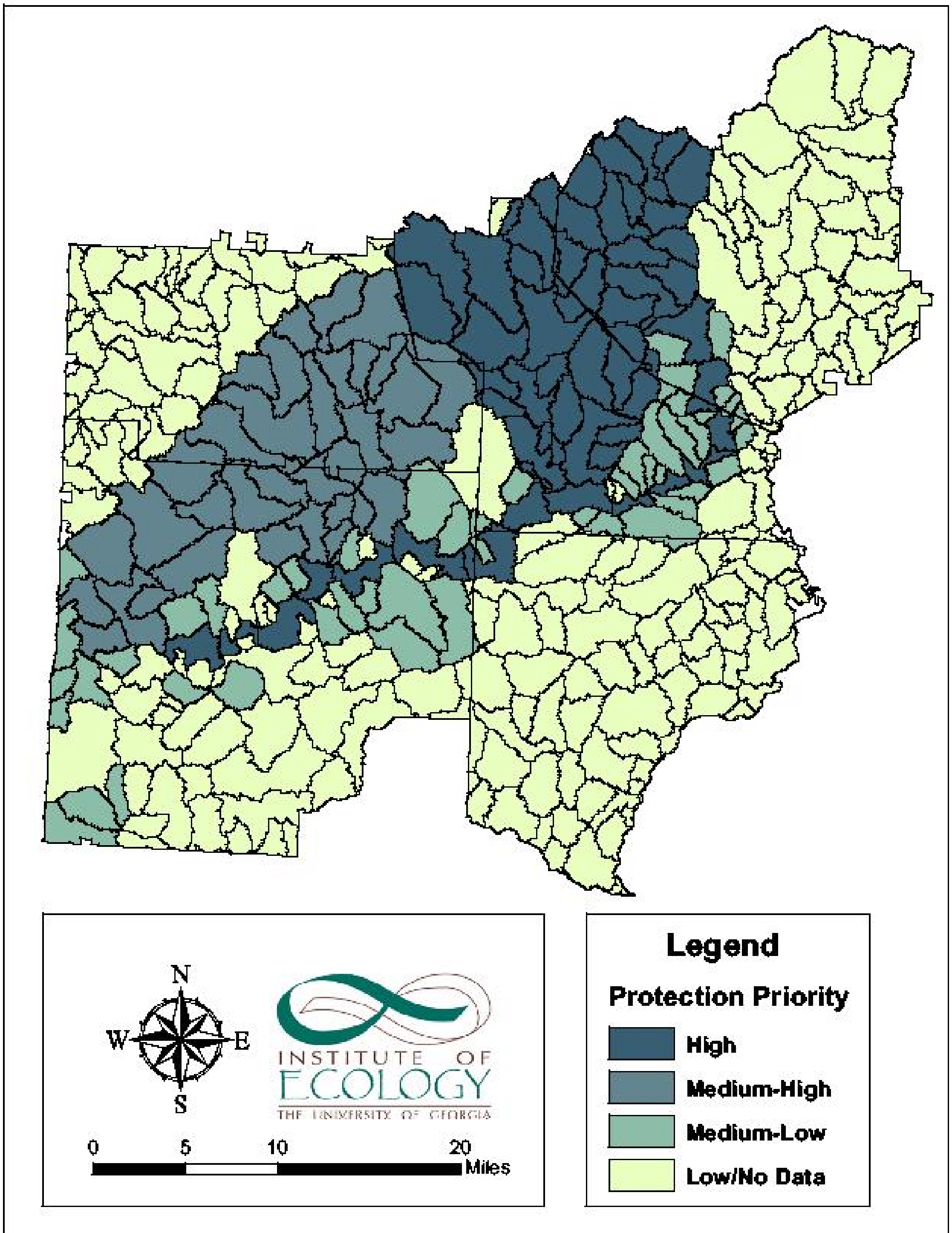


Figure 7. Tributary system protection priorities of the Upper Etowah Region.

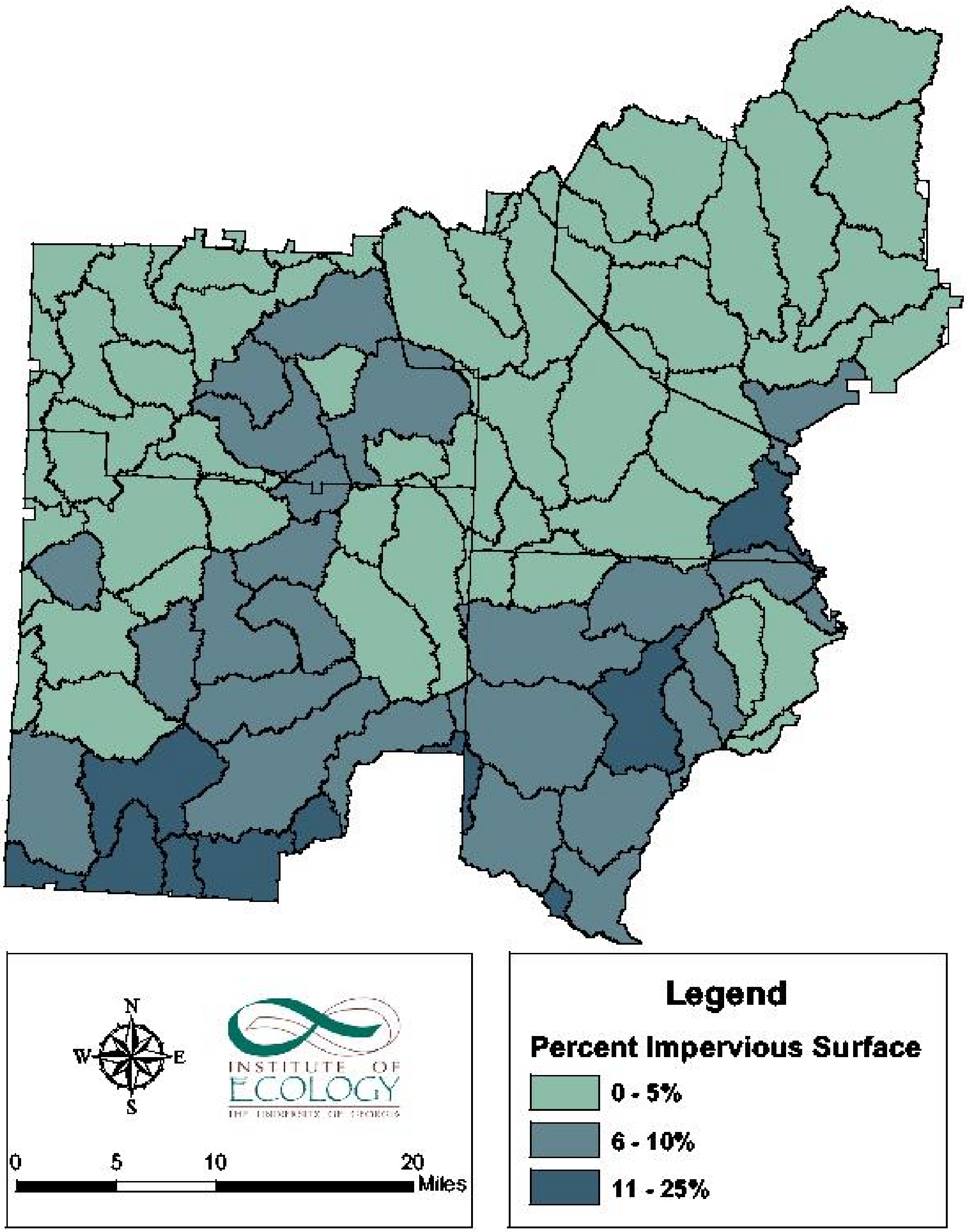


Figure 8. Percent impervious surface (1998) per HUC in the Upper Etowah Region.

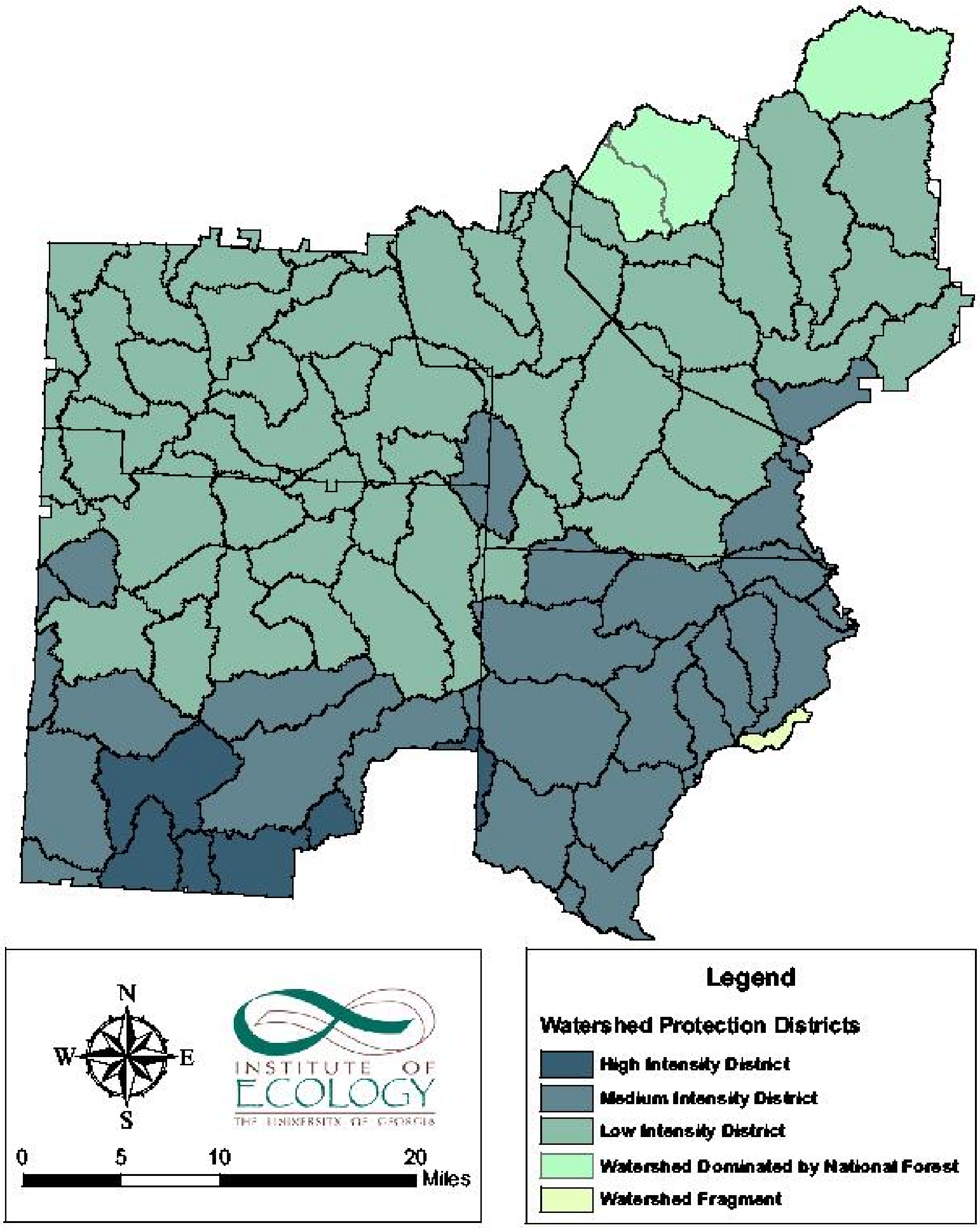


Figure 9. Watershed Protection Districts within the Upper Etowah Region.

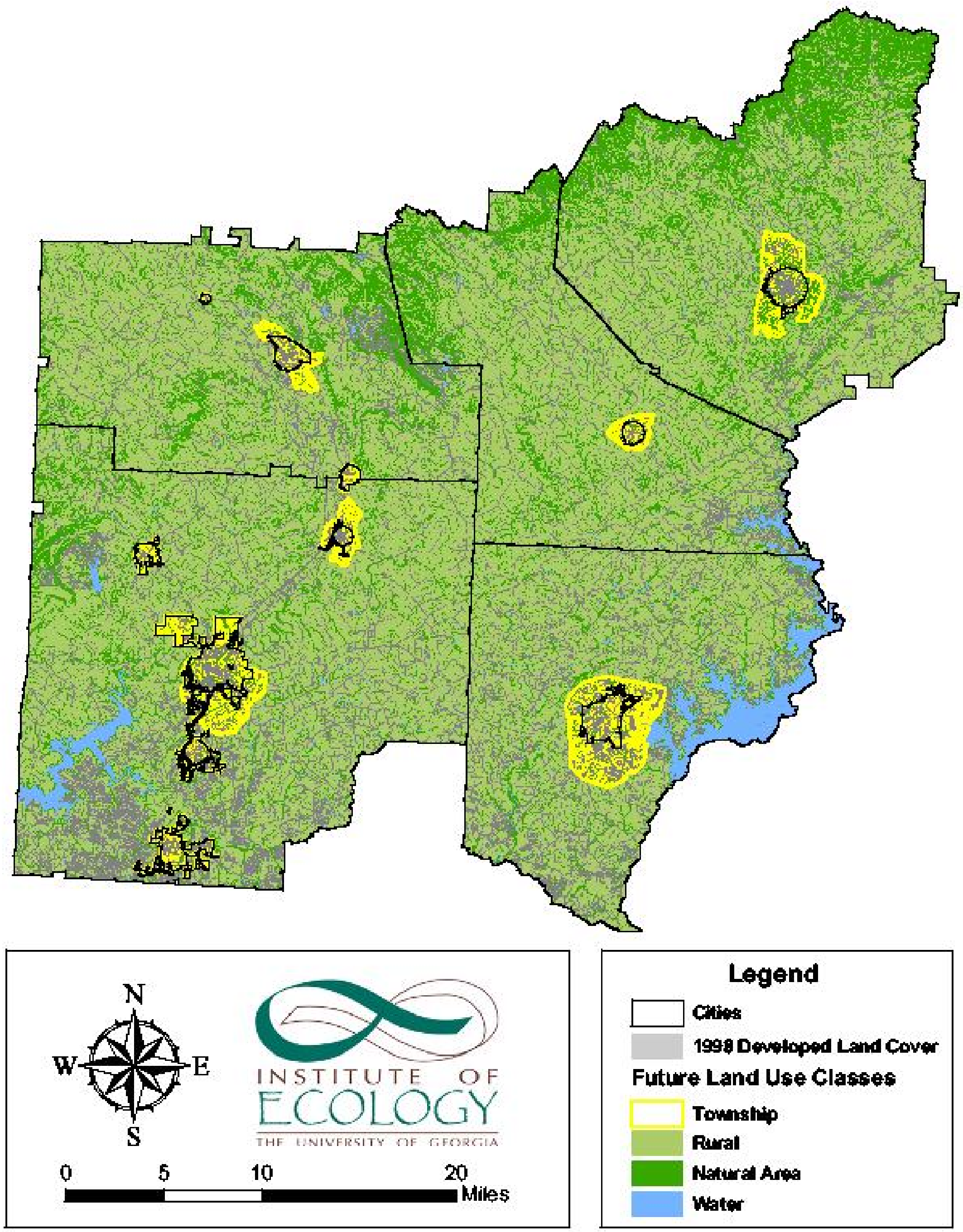


Figure 10. Alternative II Build-out Scenario.

APPENDIX A. FRACTION IMPERVIOUS SURFACE PER HUC

HUC	Protection Priority	District	Impervious Maximum	Fraction Impervious Surface 1998	Planned	Alt1	Alt2	Total Acres Planned	Alt 1	Alt 2	Impervious Acres 1998	Planned	Alt 1	Alt2
031300010401	No data	Low Intensity	0.10	0.037	0.130	0.089	0.072	8923.979	8933.108	8932.955	332.799	1160.999	793.786	639.565
031300010502	No data	Low Intensity	0.10	0.031	0.116	0.073	0.062	19550.016	19577.139	19575.260	606.966	2269.143	1426.137	1207.824
031300010601	No data	Low Intensity	0.10	0.053	0.164	0.136	0.081	13441.201	13445.704	13442.022	707.767	2200.303	1829.859	1094.258
031300010602	No data	Low Intensity	0.10	0.045	0.108	0.085	0.067	22036.152	22048.008	20448.319	986.021	2388.698	1868.278	1379.511
031300010603	No data	Low Intensity	0.10	0.039	0.125	0.106	0.086	17048.434	17057.328	16475.964	672.024	2131.325	1808.592	1419.664
031300010604	No data	Low Intensity	0.10	0.048	0.193	0.164	0.078	9862.885	9866.311	9862.867	478.271	1901.928	1616.091	773.763
031501020102	No data	Nat. Forest	0.10	0.011	0.023	0.024	0.042	1106.593	1106.622	1106.622	12.641	25.294	26.809	46.736
031501020105	No data	Low Intensity	0.10	0.037	0.070	0.066	0.065	2101.313	2107.383	2107.226	76.831	147.467	138.659	136.196
031501020501	No data	Fragment	0.10	0.037	0.082	0.077	0.068	1652.061	1653.143	1652.714	60.943	135.231	127.824	112.006
031501020502	No data	Low Intensity	0.10	0.039	0.131	0.124	0.072	12018.566	12092.453	12087.297	468.883	1569.913	1503.780	867.385
031501020503	No data	Low Intensity	0.10	0.044	0.100	0.098	0.078	1096.619	1098.830	1097.277	47.938	109.815	108.177	85.991
031501020504	No data	Low Intensity	0.10	0.032	0.094	0.089	0.063	8152.227	8166.215	8157.672	263.458	769.323	723.461	517.124
031501020505	No data	Low Intensity	0.10	0.028	0.090	0.088	0.063	9761.364	9782.114	9777.207	272.864	879.648	858.167	615.845
031501020506	No data	Low Intensity	0.10	0.030	0.076	0.075	0.063	8348.870	8372.657	8370.227	253.079	637.131	629.374	531.373
031501020507	No data	Low Intensity	0.10	0.038	0.106	0.103	0.073	10028.622	10079.468	10069.206	381.012	1059.998	1041.387	737.681
031501020508	No data	Low Intensity	0.10	0.025	0.128	0.118	0.059	5666.372	5672.911	5670.277	141.750	723.781	671.563	336.331
031501020601	No data	Low Intensity	0.10	0.031	0.081	0.071	0.062	14732.016	14760.150	14745.135	460.955	1196.940	1042.513	920.090
031501020602	No data	Low Intensity	0.10	0.024	0.062	0.051	0.054	5402.652	5402.672	5402.674	131.694	332.552	278.089	291.070
031501020603	No data	Low Intensity	0.10	0.026	0.102	0.092	0.058	3480.430	3482.707	3482.129	90.514	356.055	322.098	200.643
031501020701	No data	Low Intensity	0.10	0.026	0.116	0.079	0.053	3984.428	3984.408	3984.392	104.454	462.967	313.349	212.890
031501040103	High	Low Intensity	0.10	0.019	0.059	0.039	0.047	10288.419	10285.288	10284.405	195.216	607.056	403.113	483.642
031501040104	High	Low Intensity	0.10	0.028	0.116	0.079	0.062	17858.120	17881.390	17881.741	495.109	2063.996	1410.645	1116.152
031501040105	Medium-high	Low Intensity	0.10	0.025	0.119	0.089	0.058	19542.056	19531.682	19530.057	492.203	2323.793	1740.414	1126.318
031501040106	High	Low Intensity	0.10	0.029	0.113	0.088	0.076	23841.384	23815.904	23816.544	685.182	2697.657	2091.538	1819.528
031501040107	Medium-high	Low Intensity	0.10	0.049	0.132	0.115	0.082	18218.794	18178.709	18181.635	886.352	2410.578	2085.984	1486.617
031501040201	High	Low Intensity	0.10	0.019	0.095	0.049	0.047	20472.713	20485.451	20485.515	399.032	1938.570	996.402	965.190

	Protection		Impervious	Fraction Impervious Surface				Total Acres			Impervious Acres			
HUC	Priority	District	Maximum	1998	Planned	Alt1	Alt2	Planned	Alt 1	Alt 2	1998	Planned	Alt 1	Alt2
031501040202	High	Low Intensity	0.10	0.027	0.089	0.057	0.058	8274.971	8293.802	8293.875	223.143	738.552	473.788	477.517
031501040203	High	Low Intensity	0.10	0.028	0.087	0.061	0.061	19594.282	19618.161	19618.034	549.266	1713.841	1191.508	1192.979
031501040204	High	Low Intensity	0.10	0.026	0.094	0.075	0.060	14143.398	14127.089	14127.518	370.226	1333.373	1055.911	854.528
031501040301	Medium-high	Low Intensity.	0.10	0.022	0.074	0.047	0.056	9573.655	9556.112	9558.591	210.593	707.348	452.880	539.871
031501040306	Medium-high	Low Intensity	0.10	0.029	0.079	0.060	0.064	18390.614	18348.606	18349.143	536.950	1459.865	1093.609	1182.767
031501040401	Medium-high	Low Intensity	0.10	0.067	0.148	0.133	0.103	13728.608	13766.521	13760.286	925.441	2036.204	1828.780	1412.799
031501040402	Medium-high	Low Intensity	0.10	0.038	0.129	0.118	0.083	4983.342	4997.390	4993.640	188.880	641.006	589.475	413.563
031501040403	Medium-high	Low Intensity	0.10	0.069	0.144	0.124	0.096	18745.436	18840.109	18831.861	1290.099	2694.595	2334.655	1801.141
031501040404	Medium-high	Low Intensity	0.10	0.036	0.115	0.105	0.063	11353.969	11367.951	10371.300	411.123	1310.476	1194.754	657.072
031501040501	Medium-high	Low Intensity	0.10	0.086	0.270	0.259	0.119	7479.954	7521.278	7514.789	641.050	2018.666	1947.343	897.813
031501040502	Medium-high	Low Intensity	0.10	0.060	0.181	0.174	0.104	12226.369	12313.931	12299.834	731.690	2209.023	2140.710	1275.137
031501040503	Medium-high	Low Intensity	0.10	0.026	0.074	0.074	0.059	5895.256	5928.265	5924.585	154.902	436.773	441.557	346.992
031501040504	Medium-high	Low Intensity	0.10	0.038	0.086	0.061	0.073	8121.663	8124.538	8122.481	310.558	699.321	491.927	591.568
031501040505	Medium-high	Low Intensity	0.10	0.066	0.209	0.199	0.106	5646.137	5655.539	5654.097	372.276	1179.690	1124.549	598.119
031501040506	Medium-high	Low Intensity	0.10	0.062	0.199	0.177	0.104	8696.591	8697.296	8682.337	542.335	1731.608	1542.910	903.652
031501040601	Medium-high	Low Intensity	0.10	0.049	0.117	0.094	0.089	16762.567	16764.380	16766.703	829.367	1964.938	1576.164	1489.163
031501040602	Medium-high	Low Intensity	0.10	0.060	0.301	0.283	0.092	8693.771	8695.595	8697.534	522.911	2615.614	2457.499	799.134
031501040603	Medium-high	Low Intensity	0.10	0.078	0.266	0.244	0.120	13409.468	13411.965	12426.098	1049.319	3571.192	3272.454	1496.939
031501040605	Medium-high	Low Intensity.	0.10	0.073	0.248	0.235	0.116	9505.764	9505.935	8358.878	695.841	2354.593	2230.922	967.776
031501040701	Medium-high	Low Intensity	0.10	0.035	0.108	0.091	0.077	18692.845	18708.404	18708.388	653.315	2010.340	1707.048	1435.969
031501040702	Medium-high	Low Intensity	0.10	0.041	0.128	0.106	0.074	5642.495	5643.055	5643.056	230.989	720.133	597.358	418.996
031501040704	Medium-high	Low Intensity	0.10	0.022	0.075	0.055	0.055	12690.658	12691.228	12691.794	279.659	954.749	700.559	697.738
031300010701	No data	Med. Intensity	0.25	0.061	0.239	0.226	0.093	8800.363	8514.108	8515.463	538.317	2102.441	1924.996	793.848
031300010702	No data	Med. Intensity	0.25	0.109	0.175	0.187	0.155	8912.672	7352.243	7394.443	975.300	1555.952	1376.995	1148.793
031300010704	No data	Med. Intensity	0.25	0.069	0.172	0.176	0.106	6593.603	6004.363	6014.611	456.387	1132.109	1057.899	636.737
031300010705	No data	Med. Intensity	0.25	0.070	0.118	0.204	0.145	1866.419	1059.720	1062.998	130.468	220.832	215.861	154.181
031300010802	No data	Med. Intensity	0.25	0.086	0.194	0.192	0.114	7022.554	7041.488	7038.937	605.967	1361.776	1353.318	803.244
031300010805	No data	Med. Intensity	0.25	0.055	0.177	0.173	0.087	6348.821	6379.388	6379.403	346.360	1121.799	1104.330	556.549
031300010806	No data	Med. Intensity	0.25	0.085	0.235	0.240	0.124	5089.023	5107.699	5107.178	430.300	1193.450	1227.747	631.808
031300010807	No data	Med. Intensity	0.25	0.135	0.220	0.220	0.157	3333.525	3334.360	3334.272	449.903	733.977	733.467	524.932
031300010808	No data	Med. Intensity	0.25	0.118	0.304	0.300	0.211	11625.899	11630.654	11525.623	1377.568	3536.214	3494.456	2429.629

HUC	Protection Priority	District	Impervious Maximum	Fraction Impervious Surface 1998	Planned	Alt1	Alt2	Total Acres Planned	Alt 1	Alt 2	Impervious Acres 1998	Planned	Alt 1	Alt2
031300010901	No data	Med. Intensity	0.25	0.078	0.271	0.261	0.130	13199.950	13201.088	13201.090	1030.242	3576.981	3444.131	1711.658
031300010902	No data	Med. Intensity	0.25	0.088	0.229	0.227	0.114	8567.661	8568.589	8568.640	758.200	1961.135	1944.380	977.607
031300010906	No data	Med. Intensity	0.25	0.189	0.312	0.311	0.209	1158.241	1158.798	1158.814	218.555	360.922	360.528	242.212
031300011001	No data	Med. Intensity	0.25	0.088	0.264	0.251	0.145	22490.927	22510.583	22031.868	1971.451	5936.831	5645.826	3201.930
031300011002	No data	Med. Intensity	0.25	0.099	0.307	0.287	0.127	13562.663	13698.841	13698.825	1342.159	4160.054	3938.123	1746.197
031501040302	Low	Med. Intensity	0.25	0.030	0.102	0.069	0.065	10620.361	10601.883	10601.350	321.845	1081.196	727.137	690.254
031501040303	Low	Med. Intensity	0.25	0.035	0.080	0.089	0.070	9365.125	9321.172	9322.036	323.663	750.563	830.832	656.526
031501040304	Low	Med. Intensity	0.25	0.060	0.215	0.211	0.094	13463.489	13202.631	13214.045	810.367	2896.746	2785.411	1238.071
031501040305	Low	Med. Intensity	0.25	0.061	0.183	0.175	0.091	18703.405	18842.587	18842.592	1143.468	3413.586	3298.821	1708.230
031501040604	Low	Med. Intensity	0.25	0.089	0.234	0.221	0.175	13171.720	13178.121	12470.815	1176.041	3079.561	2912.514	2181.496
031501040703	Medium-high	Med. Intensity	0.25	0.093	0.260	0.204	0.115	5812.411	5819.264	5819.279	543.276	1512.170	1189.983	671.835
031501040801	Low	Med. Intensity	0.25	0.061	0.114	0.079	0.093	10170.248	10187.697	10192.656	617.242	1157.954	808.807	949.119
031501040805	Low	Med. Intensity	0.25	0.083	0.152	0.134	0.112	23284.020	23317.559	23334.174	1929.709	3540.540	3117.658	2611.210
031501040903	Medium-low	Med. Intensity	0.25	0.140	0.311	0.307	0.165	3304.785	3307.507	3308.061	462.374	1026.857	1015.988	544.741
031501041001	Low	Med. Intensity	0.25	0.053	0.136	0.120	0.085	12026.819	12035.079	12047.258	637.323	1634.538	1447.990	1019.568
031501041002	Medium-low	Med. Intensity	0.25	0.040	0.099	0.072	0.070	5068.882	5069.101	5069.692	201.149	500.453	365.266	353.900
031501041004	Low	Med. Intensity	0.25	0.103	0.169	0.168	0.129	13312.313	13323.554	13377.656	1367.598	2252.089	2233.324	1726.816
031300010501	No data	Nat. Forest	n/a	0.011	0.030	0.028	0.028	20337.514	20346.027	20340.286	215.319	613.151	564.189	572.345
031300010804	No data	Fragment	n/a	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.864	0.000
031501040101	High	Nat. Forest	n/a	0.020	0.041	0.036	0.045	15212.126	15221.449	15221.492	307.798	630.925	554.197	685.347
031501040102	High	Nat. Forest	n/a	0.021	0.036	0.037	0.048	7953.266	7962.494	7962.520	170.034	285.299	295.224	381.023
031501040802	Low	High Intensity	n/a	0.100	0.259	0.242	0.130	2568.251	2571.166	2571.485	257.423	664.767	622.171	334.064
031501040803	Low	High Intensity	n/a	0.109	0.171	0.141	0.135	3035.047	3040.471	3043.269	329.629	519.259	428.635	411.023
031501040804	Low	High Intensity	n/a	0.121	0.255	0.242	0.151	9007.659	9021.551	9030.747	1091.802	2295.424	2183.826	1365.607
031501040806	Low	High Intensity .	n/a	0.145	0.396	0.378	0.216	3268.676	3273.122	3274.651	472.463	1293.118	1238.772	706.786
031501040808	Low	High Intensity	n/a	0.208	0.325	0.321	0.240	7582.924	7586.549	7586.346	1576.785	2463.585	2434.316	1821.910
031501040809	Low	High Intensity	n/a	0.146	0.281	0.273	0.182	15288.855	15297.009	15288.404	2229.385	4290.976	4173.038	2784.754

APPENDIX B. MODEL SIGNIFICANT NATURAL AREAS OVERLAY ZONING ORDINANCE

ARTICLE [X] SIGNIFICANT NATURAL AREAS OVERLAY ZONE

1. PURPOSE AND INTENT

The wetlands, stream buffers and steep slopes of [*county, municipality*] provide recreational, environmental, economic, aesthetic and artistic uses to the citizens of [*county, municipality*]. Specifically, the [*county, municipality*] Board of Commissioners finds that the protection of the significant natural areas is necessary to conserve the following functions:

1. Wildlife habitat (terrestrial and aquatic);
2. Community health and safety (flood control, water quality protection, etc.);
3. Community historic needs (Native American artifacts, mill sites, etc.);
4. Recreational purposes (hunting, fishing, paddling, etc);
5. Aesthetic and quality of life contributions (scenery, clean air and water, etc.);
6. Educational, scientific, and artistic resources;
7. Economic development (forestry, agriculture, suburban growth, etc.).

Therefore, the purpose of this ordinance is to protect the citizens of [*county, municipality*] best interest by preserving the functions of significant natural areas. The intent of this ordinance is to amend the Zoning Ordinances of [*county, municipality*] by establishing significant natural area overlay zones of restricted development, as identified in the series of overlay district maps.

The standards and regulations set forth in this ordinance are created under the authority of the [*county, municipality*]'s Home Rule and zoning powers defined in the Georgia Constitution (Article IX, Section 2). In the event of a conflict between or among any provisions of this ordinance, or any other ordinances of [*county, municipality*], the requirement that is most restrictive and protective of these natural areas shall apply.

2. TITLE

This ordinance shall be known as "The Significant Natural Areas of [*county, municipality*]".

3. DEFINATIONS

"Existing land use" means a land use which, prior to the effective date of this ordinance, is either:
(1) completed; or
(2) ongoing, as in the case of agricultural activity; or
(3) under construction; or
(4) fully approved by the governing authority; or

(5) the subject of a fully completed application, with all necessary supporting documentation, which has been submitted for approval to the governing authority or the appropriate government official, for any construction-related permit.

"Land or water disturbing activity" means any grading, scraping, excavating, draining or filling of land or water, clearing of vegetation and any construction, rebuilding, or significant alteration of a structure.

"Stream buffer" means the area of land 75 feet on either side of all streams in [*county, municipality*], measured as a line extending perpendicularly from the stream bank.

"Second order stream or higher" means any stream that is formed by the confluence of two or more other streams, as indicated by solid or dashed blue lines on the United States Geological Survey 7.5 minute quadrangle maps, of the most recent edition.

"Significant natural area" means the lands and water that constitute the stream buffers, steep slopes and wetlands of [*county, municipality*]. Including but not limited to the areas identified on the significant natural areas map.

"Significant natural areas map" means the map produced by or for the [*county, municipality*] that illustrates the location and extent of the significant natural areas within the [*county, municipality*].

"Steep slopes" means lands that have average slopes over 25%, as measured over horizontal distances of fifty feet or more.

"Stream" or "River" means all of the following:

(a) any perennial stream or river (or portion thereof) that is portrayed as a solid line on the significant natural area map; and
(b) any perennial stream or river (or portion thereof) that is portrayed as a solid line on a United States Department of Agriculture Soil Survey Map of the most recent edition; and
(c) any intermittent stream or river (or portion thereof) that is portrayed as a dashed line on a United States Department of Agriculture Soil Survey Map of the most recent edition; and
(d) any lake or impoundment that does not lie entirely within a single parcel of land; and
(e) any other stream as may be identified by [*county, municipality*].

"Watershed" means a division of the Upper Etowah Region into one of the 12-digit hydrologic unit codes assigned by the United States Geological Society.

"Wetlands" means the geographical areas of one-fourth acre or more inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Including but not limited to wetlands as shown on the significant natural area map and National Wetland Inventory maps.

4. SIGNIFICANT NATURAL AREAS REGULATIONS

4.1 The Significant Natural Areas Zone (SNAZ) is an overlay zone that encompasses all the land and water within the stream buffers, steep slopes and wetlands in [*county, municipality*]. The SNAZ must be maintained in a naturally vegetated state. Any property or portion thereof that lies within the SNAZ is subject to the restrictions of the SNAZ as well as any and all zoning restrictions that apply to the tax parcel as a whole.

4.2 The following land uses are prohibited within the significant natural area:
- (a) any land-disturbing activity;
- (b) septic tanks and septic tank drainfields;
- (c) building, accessory structures, and all types of impervious surface;
- (d) hazardous and sanitary waste landfills;
- (e) receiving areas for toxic or hazardous waste or other chemical or thermal pollutants;
- (f) mining;
- (g) stormwater retention or detention facilities, except those built as constructed wetlands that meet the approval of the Office f Planning and Zoning of [*county, municipality*].

5 EXCEPTIONS TO THE SIGNIFICANT NATURAL AREAS

5.1 The following land uses and activities are excepted from the provisions of Section 4:
- (a) Temporary emergency procedures necessary for the protection of life, health, safety, or property.
- (b) Existing land uses, except as follows:
  1. when the existing land use, or any building or structure involved in that use, is enlarged, increased, or extended to occupy a greater area of land; or
  2. when the existing land use, or any building or structure involved in that use, is moved (in whole or in part) to any other portion of the property; or
  3. when the existing land use ceases for a period of more than one year.
- (c) Agriculture production, provided that it is consistent with all state and federal laws, regulations promulgated by the Georgia Department of Agriculture, and best management practices established by the Georgia Soil and Water Conservation Commission.
- (d) Selective logging, except within 25 feet of a stream and provided that logging practices comply with the best management practices set forth by the Georgia Forestry Commission.
- (e) Crossings by transportation facilities and utility lines and needed repair and maintenance of said crossings. However, issuance of permits for such uses or activities is contingent upon the completion of a feasibility study that identifies

alternative routing scenarios that do not violate the SNAZ, as well as a mitigation plan to minimize impacts on the SNAZ.

(f) Temporary stream, stream bank, wetland and vegetation restoration projects, the goal of which is to restore the stream, wetland or riparian zone to an ecologically healthy state.

(g) Structures and the maintenance and repair of such structures, which, by their nature, cannot be located anywhere except within the SNAZ. These include but are not limited to docks, boat launches, public watersupply intake structures, facilities for natural water treatment and purification, and public wastewater treatment plant sewer lines and outfalls.

(h) Wildlife and fisheries management activities consistent with the purposes of Section 12-2-8 (as amended) of the Official Code of Georgia Annotated.

(i) Construction of a single family residence, including the usual appurtenances, provided that:

1. based on the size, shape or topography of the property, as of the effective date of this ordinance, it is not reasonably possible to construct a single-family dwelling without encroaching upon the SNAZ; and
2. the dwelling conforms with all other zoning regulations; and
3. the dwelling is located on a tract of land containing at least two acres. For purposes of these standards, the size of the tract of land shall not include any area that lies within the protected river or stream; and
4. there shall only be one such dwelling on each two-acre or larger tract of land; and
5. septic tank drainfields shall not be located in a riparian buffer area, although a septic tank or tanks serving such a dwelling may be located within the SNAZ.

(j) Activities not requiring a structure but that are accessory to residential or other permitted primary uses of lands or water, including the following:

1. Normal grounds maintenance without chemical or nutrient fertilizing.
2. Tree trimming and pruning so as not to kill any native vegetation.
3. Ordinary repair and maintenance of existing stone or retaining walls.

(k) Trails meeting all of the following

1. Trails with widths not exceeding 30 inches.
2. Trails with slopes not exceeding 20 percent as measured in horizontal distances of 50 feet or more.
3. Trails not placed in streams or wetlands.
4. Trails containing no impervious surface.

(l) Other uses permitted by the Georgia Department of Natural Resources or under Section 404 of the Clean Water Act.

5.2 Notwithstanding the above, all excepted uses, structures or activities shall comply with the requirements of the Erosion and Sedimentation Act of 1975 and all applicable best management practices and shall not diminish water quality as defined by the Clean Water Act.

6 VARIANCES TO THE SIGNIFICANT NATURAL AREAS

6.1 A variance is a reduction in the significant natural area. A property owner may request a variance from the requirements of the SNAZ by preparing the appropriate application with the [*county, municipality*] Office of Planing and Zoning. Such requests shall be granted or denied by application of the criteria set forth below in section 7.3 and will be subject to the conditions set forth below in section 7.4. Under no circumstances may an exception be granted which would reduce the SNAZ to an extent less than the minimum standards established by state or federal law.

6.2 Each applicant for a variance must provide documentation that describes
- (a) existing site conditions, including the status of the SNAZ; and
- (b) the needs and purpose for the proposed project; and
- (c) justification for seeking the variance, including how SNAZ encroachment will be minimized to the greatest extent possible; and
- (d) a proposed mitigation plan that offsets the effects of the proposed encroachment during site preparation, construction, and post-construction phases.

6.3 No variance shall be issued unless the [*county, municipality*] Zoning Board of Appeals determines that:
- (a) the requirements of the SNAZ represent an extreme hardship for the landowner such that little or no reasonable economic use of the land is available without reducing the extent of the SNAZ; or
- (b) the size, shape or topography or the property, as of the effective date of this ordinance, is such that it is not possible to construct a single family dwelling without encroaching upon the SNAZ.

6.4 Any variance issued by the [*county, municipality*] Zoning Board of Appeals will meet the following conditions:
- (a) the extent of the SNAZ is reduced by only the minimum amount necessary to provide relief; and
- (b) land or water disturbing activities must comply with the requirements of the Erosion and Sedimentation Act of 1975 and all applicable best management practices. Such activities shall not impair water quality, as defined by the Clean Water Act and the rules of the Georgia Department of Natural Resources, Environmental Protection Division; and
- (c) as an additional condition of issuing the variance, the [*county, municipality*] Zoning Board of Appeals may require water quality monitoring downstream from the site of the land or water disturbing activity or within any effected wetlands to ensure that water quality is not impaired

7 ENFORCEMENT AND PENALITIES

7.1 Any development activity that is commenced or is conducted contrary to this ordinance may be restrained by injunction or otherwise abated in a manner provided by law.

7.2 When the Public Works Director of [*county, municipality*] determines that an activity is not being carried out in accordance with the requirements of this ordinance, it shall issue a written notice of violation to the owner of the property. The notice of violation shall contain:

1. the name and address of the owner or applicant;
2. the address when available or a description of the building, structure or land upon which the violation is occurring;
3. a statement specifying the nature of the violation;
4. a description of the remedial measures necessary to bring the development activity into compliance with this ordinance and a time schedule for the completion of such remedial action;
5. a statement of the penalty or penalties that shall or may be assessed against the person to whom the notice of violation is directed;
6. a statement that the determination of violation may be appealed to the Public Works Director by filing a written notice of appeal within 30 days of service of notice of violation.

7.3 Persons receiving a notice of violation will be required to halt all construction activities. This "stop work order" will be in effect until the Public Works Director confirms that the development activity is in compliance and the violation has been satisfactorily addressed. Failure to address a notice of violation in a timely manner can result in civil, criminal, or monetary penalties in accordance with the enforcement measures authorized in this ordinance.

7.4 In addition to or as an alternative to any penalty provided herein or by law, any person who violates the provisions of this ordinance shall be punished by a fine or not less than X dollars or by imprisonment for a period not to exceed X days, or both such fine and imprisonment. Such person shall be guilty of a separate offense for each day during which the violation occurs or continues.

7.5 Any violator may be required to restore land to its undisturbed condition. In the event that restoration is not undertaken within a reasonable time after notice, the Public Works Director may take necessary corrective action, the cost of which shall become a lien upon the property until paid.

8 REPEAL CAUSE

The provisions of any ordinances or resolutions or parts thereof in conflict herewith are repealed, save and except such ordinances or resolutions or parts thereof which provide stricter standards than those provided herein.

9 SEVERABILITY

Should any section, subsection, clause or provision of this Article be declared by a court of competent jurisdiction to be invalid, such decision shall not affect the validity of this Article in whole or any part thereof other than the part so declared to be invalid.

10 AMENDMENT

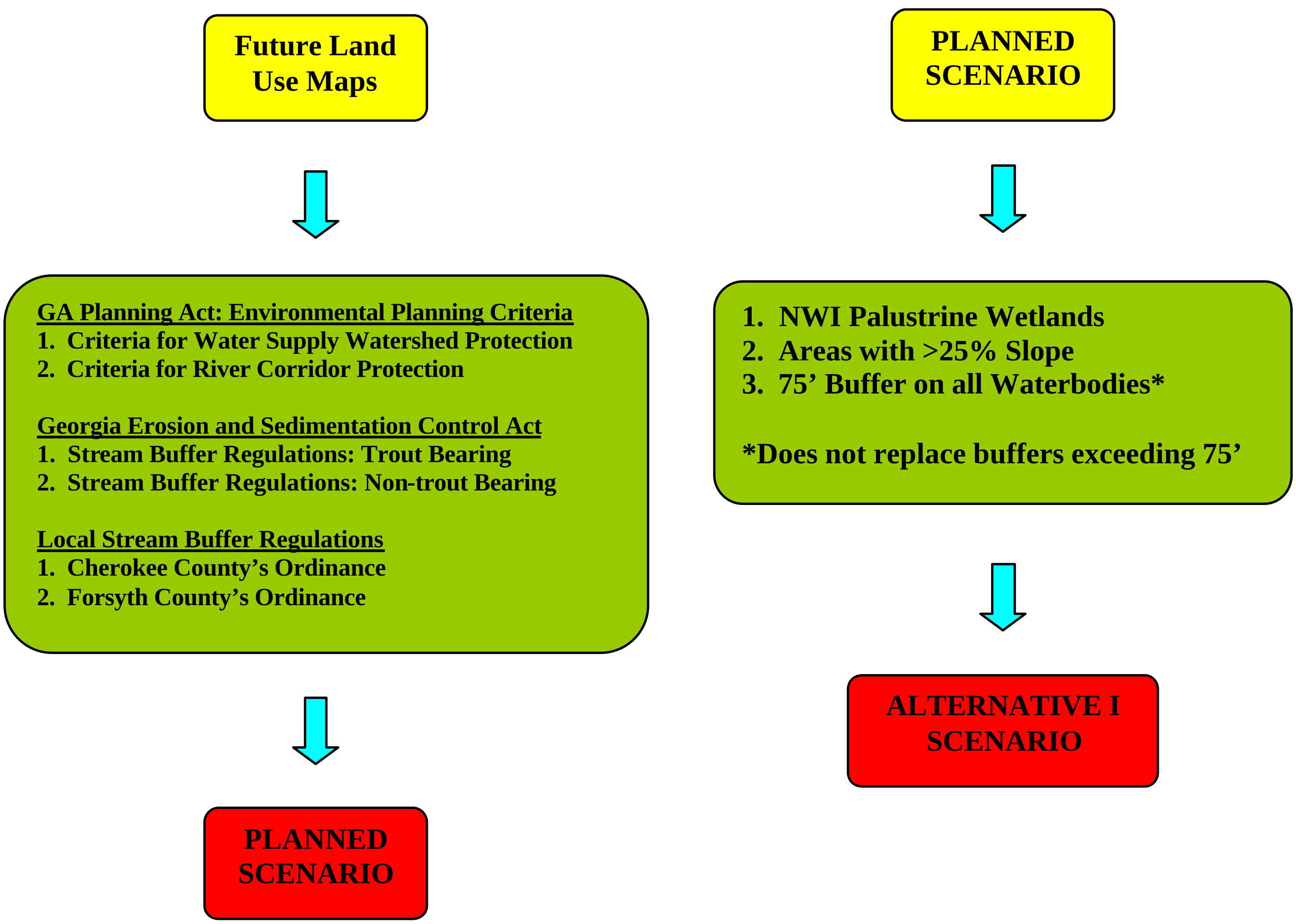
This Article may be amended from time to time by resolution of the Board of Commissioners of [*county, municipality*]. Such amendments shall be effective as specified in the adopting resolution.

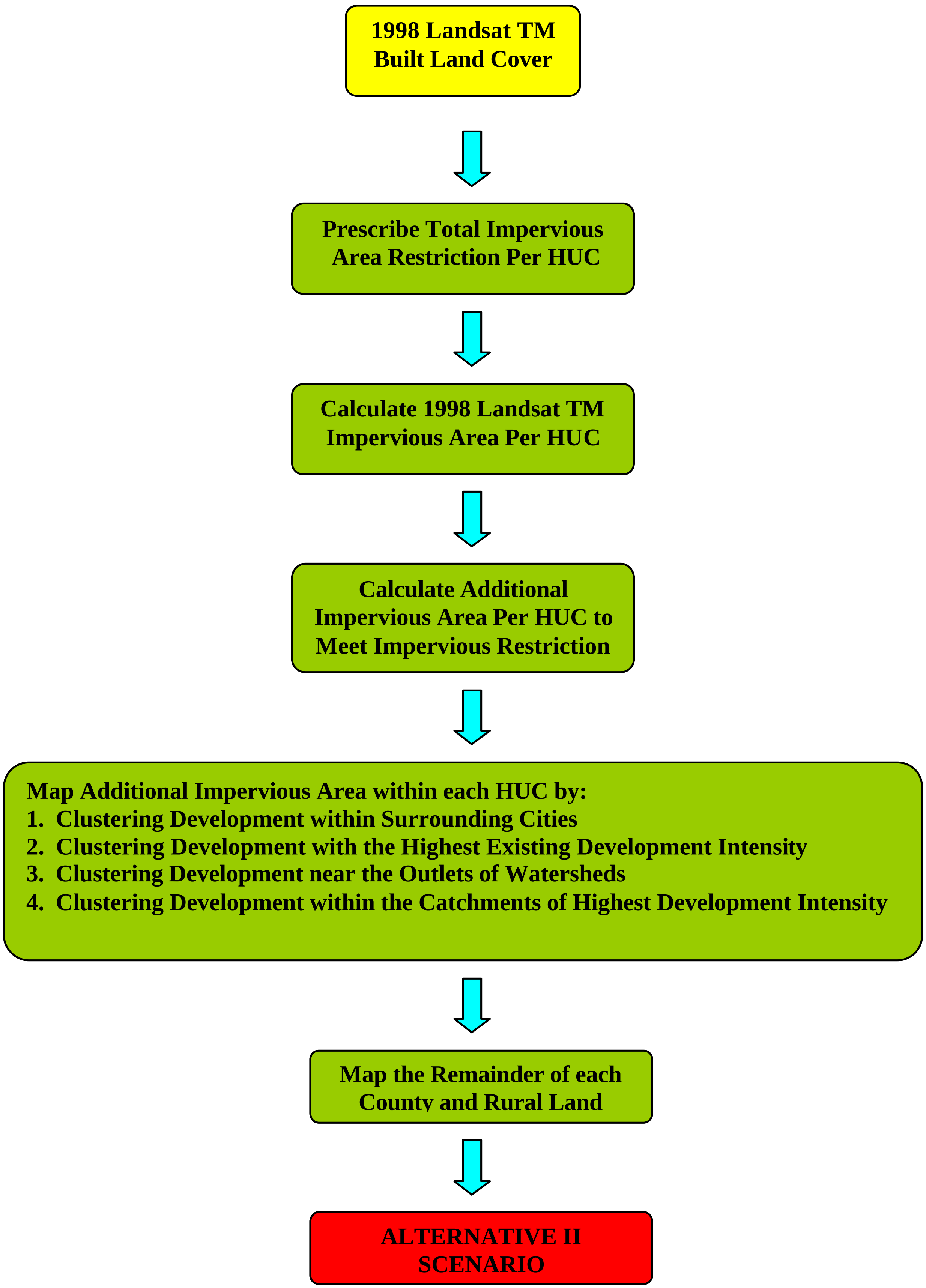
11 EFFECTIVE DATE

This Article shall become effective upon its adoption.

APPENDIX C: METHODS OF DEVELOPING AND ANALYZING SCENARIOS

I. Scenario Development




1998 Landsat TM Built Land Cover
Prescribe Total Impervious Area Restriction Per HUC
Calculate 1998 Landsat TM Impervious Area Per HUC
Calculate Additional Impervious Area Per HUC to Meet Impervious Restriction
Map Additional Impervious Area within each HUC by:
1. Clustering Development within Surrounding Cities
2. Clustering Development with the Highest Existing Development Intensity
3. Clustering Development near the Outlets of Watersheds
4. Clustering Development within the Catchments of Highest Development Intensity
Map the Remainder of each County and Rural Land
ALTERNATIVE II SCENARIO

II. Stream Health Analysis

III. Rural Analysis