PP RS Public Policy Research Series

Protecting Stream and River Corridors

Creating Effective Local Riparian Buffer Ordinances

by Seth J. Wenger and Laurie Fowler

Model Ordinance Included

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Richard W. Campbell, *Series Editor*

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Protecting Stream and River Corridors: Creating Effective Local Riparian Buffer Ordinances

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Foreword

Sooner or later, every Georgia county or municipality that has experienced a significant amount of growth must turn its attention to the issue of water quality. Local officials now have a number of tools at their disposal for offsetting the impacts of development and protecting aquatic resources. Among the most cost-effective of these methods is the riparian buffer ordinance. Buffers are mandated by state law and in recent years have been the subject of much debate. The purpose of this paper, part of the Public Policy Research Series of the Carl Vinson Institute of Government, is to inform that debate and to provide local officials with the information they need to craft buffer ordinances that are appropriate for their jurisdictions.

The foundation of *Protecting Stream and River Corridors: Creating Effective Local Riparian Buffer Ordinances* is a set of buffer-width guidelines that are based upon one of the most comprehensive scientific reviews conducted to date. This scientific basis is designed to ensure that buffer ordinances established in accordance with the recommendations will meet water quality goals and be defensible. Guidelines are also provided for minimizing the possibility of infringing on the rights of property owners, which is often a concern in the introduction of new land-use ordinances. A model ordinance specifically designed for Georgia counties and municipalities is included.

The authors of this paper are Seth J. Wenger, a conservation ecologist and policy analyst at the University of Georgia Institute of Ecology; and Laurie Fowler, director of Public Service and Outreach at the Institute of Ecology. Ms. Fowler also holds an appointment at the University of Georgia School of Law and has 17 years of experience in environmental law and the development of local policies for natural resource protection. Dr. Wenger is the author of *A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation.*

To ensure that the guidelines presented here are reasonable, the authors asked several leading riparian buffer researchers, as well as other scientists, to review them. Their comments and changes were incorporated into the final recommendations.

The intent of the Public Policy Research Series is to present objective and systematic research on complex policy problems and issues confronting the state of Georgia and its local governments. As part of this effort, *Protecting Stream and River Corridors* is targeted at elected officials who are considering establishing or improving their riparian

buffer ordinances, along with planning and zoning officials who will implement and enforce such ordinances. Property owners, developers, and other citizens may also find the contents informative. We hope that these individuals benefit from the publication.

Henry M. Huckaby
Director
Carl Vinson Institute of Government

April 2000

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Numerous local, federal, and state officials were very helpful: Ken Patton, Cherokee County Planning and Zoning Office; Gail Cowie, Institute for Community and Area Development; Dee West, City of Alpharetta; Michael Gleaton, Jim Frederick, and Lucy Herring, Georgia Department of Community Affairs; Lee Carmon and Joseph Tichy, Northeast Georgia Regional Development Center (RDC); Lisa Hollingsworth, Chattahoochee-Flint RDC; Tom O'Bryant and Larry Sparks, Georgia Mountains RDC; Nap Caldwell and Chris Skelton, Georgia Department of Natural Resources; and Jimmy Bramblett and Steve Lawrence, Natural Resources Conservation Service.

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Contents

Executive Summary

The purpose of this paper is to support the efforts of local governments in Georgia that have made policy decisions to develop riparian buffer programs. A riparian buffer is a strip of naturally vegetated land along a stream or river which is protected to maintain healthy aquatic ecosystems and to provide a range of other environmental, economic, and social benefits. These benefits are numerous:

- Trapping and removing sediment from runoff
- Stabilizing stream banks and reducing channel erosion
- Trapping and removing nutrients and contaminants
- Storing flood waters, thereby reducing property damage
- Maintaining habitat for fish and other aquatic organisms
- Providing terrestrial habitat
- Maintaining good water quality
- Improving aesthetics, thereby increasing property values
- Offering recreational and educational opportunities

Despite their importance, several barriers stand in the way of effective buffer ordinances. For one, the riparian buffer requirements imposed by state laws do not provide a uniform and effective system of protection. For another, concerns over property rights have led many local officials to shy away from ordinances, however beneficial, due to fears of "takings" lawsuits. This paper is intended to help local governments develop effective, comprehensive riparian buffer ordinances that, properly administered, will not generate takings claims. A model ordinance is included.

In a monograph published by the Institute of Ecology of the University of Georgia (Wenger 1999), the author provides a thorough analysis of scientific buffer research that is applicable to Georgia. That review determined that the most effective buffers are at least 30 meters or 100 feet wide, composed of native forest, and are applied to all streams, including very small ones. Ideally, the width of the buffer will vary based on local conditions such as slope, width of the floodplain, presence of wetlands, and other factors. Two variable-width formulas that incorporate such factors are presented. The first specifies a minimum width of 100 feet, while the second provides for a minimum width of 50 feet. For local governments that find a variable-width formula too cumbersome to administer, recommendations are also provided for a fixed width buffer of 100 feet. Other widths are possible and reasonable, but narrower buffers provide significantly less benefits, and no buffer under 50 feet can be considered very effective.

The following activities and structures are not appropriate within a riparian buffer:

- Land-disturbing activities, including construction
- Impervious surfaces
- Logging roads
- Mining
- Septic tank drain fields
- Application of pesticides and fertilizer
- Waste disposal sites
- Livestock

The 1999 study included a review of existing riparian buffer ordinances from Georgia and neighboring states. Among the local governments in Georgia that have passed effective buffer ordinances are Alpharetta, Douglas County, and Fulton County. These ordinances, together with selected buffer programs from a more thorough national review by other researchers in 1993, can provide guidance for other local governments in Georgia and are discussed in this paper. The study showed that a local buffer ordinance can take a number of different forms. For those local governments with zoning laws, an ordinance that creates a buffer overlay district is the best approach. The next best alternative is a stand-alone ordinance. Buffer protection could also be incorporated into a floodplain ordinance or an erosion and sedimentation control ordinance.

An effective riparian buffer ordinance will have the following characteristics:

1. It will meet the minimum standards for protection under the Georgia Planning Act and the Mountain and River Corridor Protection Act. A good buffer ordinance will not only adhere to state requirements, but will incorporate those requirements into a single set of local regulations, making it easy to administer.
2. It will provide for flexibility and variance procedures. In many cases, it is possible to slightly reduce the width of a portion of the buffer to accommodate the needs of a landowner while not significantly affecting buffer performance. This can be incorporated into an ordinance through rules for "minor exceptions" or "buffer averaging." In extreme cases, a variance that significantly reduces the buffer width will need to be issued to provide regulatory relief to property owners. The buffer ordinance should include variance criteria and procedures that are stringent but fair.
3. It will provide an exception for existing land uses. In other words, properties are only affected by the buffer ordinance when they

change use—for example, when agricultural land is developed for residences.

4. It will provide exceptions for certain activities. Agriculture is traditionally outside the regulatory domain of local governments and may be exempted (although certain restrictions on pesticide and fertilizer application are appropriate). Forestry is acceptable within limits, although cutting within 50 feet of the stream should not be allowed. Structures such as boat ramps, which by their nature need to be on or near a stream, are also excepted.
5. It will include guidelines for buffer crossings, which should be minimized, and buffer restoration, which is sometimes necessary.

In administering a buffer ordinance, good communication with property owners is essential. This reduces the likelihood of opposition based on irrational fears and misunderstandings regarding the law. Proper enforcement is also a necessity, although previous experiences suggest that the enforcement burden need not be great. A simple and reliable system for determining buffer width—for those local governments with a variable-width ordinance—is also important. A model ordinance, an appendix to this paper, incorporates all of the provisions discussed here.

A buffer ordinance based on the recommendations contained in this paper and properly enforced should withstand any legal challenges based on property rights. One concern to local governments and land owners is the takings issue. Legally, a takings can occur when government regulates property to such a degree that little economic use is left to the landowner. However, a buffer ordinance will not usually preclude use of a property and will not necessarily reduce property values. In those cases where properties are severely impacted, the owner should receive a variance.

To analyze the impact of buffers on property rights, we examined the proportion of land parcels covered by buffers of various widths (50, 75, and 100 feet). The study showed that parcels of less than 1-2 acres can be significantly impacted by relatively narrow buffers. However, since parcels of this size or smaller have generally been dedicated to residential use and are unlikely to be converted to other uses, they are exempted from an ordinance. If they are not exempted, their owners would qualify for a variance. Large parcels of 70 acres or more usually lose less than 10 percent of their land area to buffers, a portion that should not significantly reduce their value (especially when the economic benefits of buffers are considered). Often,

Recommendations

Pass a riparian buffer ordinance based on the included model.

Develop a public information campaign explaining benefits and features of buffer ordinances.

Identify critical riparian areas in which existing land uses threaten water quality.

Identify wildlife areas, historic/prehistoric sites, and other areas meriting preservation.

Establish impervious surfaces limits.

Properly enforce erosion and sedimentation control statutes.

Amend existing floodplain ordinance to emphasize importance of limiting floodplain development and to prohibit certain activities harmful to water quality.

Set a 25 NTU turbidity standard.

the riparian zone is the least suitable area for development and is left wooded anyway. For example, a land cover analysis showed that in Cherokee County, a typical urbanizing county, over 89 percent of the area along streams is still forested.

Although riparian buffers can reduce the useful area of properties, they can also increase property values and provide other economic benefits. Properties near healthy, protected streams are worth more than properties located farther away or near unhealthy, aesthetically unpleasant waterways. Buffers protect water quality, which has immense economic value. By keeping sediment out of rivers, for example, buffers reduce the expenses of drinking water treatment plants. Clean streams and rivers are also valuable for recreation and tourism, and are vital factors in attracting new businesses and residents. Finally, protecting streams with buffers is a low-cost way to enhance the survival of endangered aquatic species. In short, riparian buffers are not only essential tools for environmental protection, they are also important factors in the long-term economic health of a community.

Introduction

The health of streams and rivers depends to a great extent on the lands that surround them. Over the last two decades, researchers have shown that preserving naturally vegetated corridors along streams can "buffer" them from the degrading effects of nonpoint pollution while reducing the impact of floods, providing habitat for wildlife, and offering recreational benefits to people. Protected stream corridors or "riparian buffers" are now widely advocated by a range of federal and Georgia state agencies for protecting water quality on agricultural, forestry, and other lands (GSWCC 1994, GFC 1999, USEPA 1998). In Georgia, local governments are required to protect buffers along certain streams and rivers by the Georgia Planning Act and the Mountain and River Corridor Protection Act.

Key Terms

In its most basic definition, ***riparian*** refers to the land adjoining a body of water.

A ***riparian buffer*** is an undisturbed naturally vegetated strip of land that lies along a stream, river, or lake and provides such functions as protecting water quality, providing wildlife habitat, and storing flood waters.

However, the minimum standards for riparian buffers issued by the Department of Natural Resources' Environmental Protection Division (EPD) are not based on current scientific research and do not provide a strong level of resource protection. Only certain streams and rivers are protected, and many activities that are harmful to water quality—such as mining—are exempted from regulation. Counties and municipalities intending to develop effective, comprehensive riparian buffer ordinances that provide sound protection for water quality and wildlife will find the minimum standards insufficient. Local governments have the authority to develop alternative, more effective ordinances, but thus far scientifically based guidelines for buffer ordinances have not been available to them. Many officials worry that without solid scientific support, a comprehensive buffer ordinance could face legal challenges from developers and other property owners.

The purpose of this paper is to serve as a resource for local governments that plan to develop comprehensive riparian buffer ordinances, by presenting scientifically based guidelines which evolved from an analysis of scientific literature published as *A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation* (Wenger 1999). Even with these guidelines, however, many local governments will face an uphill struggle in establishing stream buffer ordinances as they encounter property owners concerned that a buffer ordinance will infringe upon their rights. Local governments must decide which form an ordinance will take and how it will be administered. This paper is intended to help local governments make those decisions by reviewing existing buffer programs, discussing the different legal tools available and how to avoid a "takings" claim, and by including a model buffer ordinance that integrates its recommendations.

Exceeding Minimum Standards

In Georgia, stream corridor protection is mandated by several laws: the Erosion and Sedimentation Act, the Georgia Planning Act, the Mountain and River Corridor Protection Act, and the Metropolitan River Protection Act. All require that affected local governments develop plans and ordinances consistent with the laws and with any minimum standards issued by the EPD. Because of this abundance of requirements, some local governments find themselves with a patchwork of protected stream corridors of varying width and extent, a situation that can be confusing and aggravating to property owners and officials alike. Such a system has little scientific basis and is unlikely to afford effective protection to aquatic resources. Complicating matters further, various federal and state agencies encourage the protection of stream buffers as best management practices (BMPs) on agricultural and forestry land. These buffers may be of greater or lesser width than those required by state laws.

Key Terms

As used in this paper, ***stream buffer*** and ***protected stream corridor*** are synonymous with riparian buffer.

A comprehensive riparian buffer ordinance can simplify these requirements by integrating them into one uniform set of rules. Such an ordinance—with a scientific foundation—will provide water quality and wildlife habitat insurance for the future. A buffer ordinance is essentially a land-use planning tool that directs new development away from streams and rivers. Generally, this is more cost-effective in controlling pollution than trying to retrofit engineering solutions once an area has developed. Federal environmental protection laws such as the Clean Water Act, the Safe Drinking Water Act, and the Endangered Species Act can impose significant costs on local governments that have not taken adequate steps to protect aquatic resources. For example, the recent listing of nine species of salmon as threatened or endangered is expected to impose major restrictions on certain activities in the Pacific Northwest—restrictions that could have been avoided had the fishes' habitat been better protected previously (Verhovek 1999).

The Functions and Characteristics of Riparian Buffers

Riparian buffers perform a range of functions with economic, social, and ecological value. These include the following:

- Trapping/removing sediment in runoff
- Reducing stream bank erosion
- Trapping/removing phosphorus, nitrogen, and other nutrients that can lead to eutrophication of aquatic ecosystems
- Trapping and removing other contaminants, such as pesticides
- Contributing leaves and other energy sources to the stream
- Storing flood waters, thereby decreasing damage to property
- Maintaining habitat for fish and other aquatic organisms by moderating water temperatures and providing woody debris
- Providing habitat for amphibious and terrestrial organisms
- Maintaining base flow in stream channels
- Maintaining good water quality
- Improving the aesthetic appearance of stream corridors (which can increase property values)
- Offering recreational and educational opportunities to residents and tourists

Because they provide all of these services, riparian buffers can be thought of as a "conservation bargain": a small investment that yields large returns. Preserving a relatively narrow strip of land along streams and rivers—land that is frequently less suitable for other uses—can help to maintain good water quality, provide habitat for wildlife, protect people and buildings against flood waters, and extend the life of reservoirs. "Vegetative buffer programs, however, are rarely developed to fully consider the multiple benefits and uses that they offer to resource managers and to the general public" (Desbonnet et al. 1994). Often, buffer programs are developed for a single goal, such as trapping sediment. However important this goal may be, programs with such a narrow focus inevitably undervalue buffers (and riparian zones in general) and may lose popular support if they don't meet this goal. On the other hand, programs that promote the multiple functions of buffers are likely to enjoy a wider and stronger base of support, especially when people recognize the economic benefits they can provide. We strongly recommend the establishment of multifunctional riparian buffer protection programs.

Results of Riparian Buffer Research

A riparian buffer ordinance should be based on scientific research. To establish this scientific foundation, the authors reviewed the research that has been conducted on riparian buffers, carefully analyzing some 140 scientific articles and publications. From this review and the input of riparian buffer researchers and other scientists, we developed recommendations for buffer width, extent (i.e., what streams should be protected), and vegetation type (e.g., forest or grass). This section is organized by riparian buffer function. In a subsequent section, the guidelines for riparian buffer ordinances developed from this review are presented.

Reducing Erosion and Sedimentation

Sediment is the most significant pollutant in many streams and rivers. Research has shown that vegetative buffers are effective at trapping sediment from runoff and at reducing channel erosion. Studies have yielded a range of recommendations for buffer widths; buffers as narrow as 4.6 meters (15 feet) have proven fairly effective in the short term (less than one year). Studies suggest that long-term trapping of sediment requires much wider buffers. It appears that a 30-meter (100-foot) buffer is sufficiently wide to trap sediment under most circumstances, although buffers should be extended for steeper slopes. To be most effective, buffers must extend along all streams, including intermittent and ephemeral channels. Buffers must be augmented by limits on impervious surfaces and strictly enforced on-site sediment controls. Both grassed and forested buffers are effective at trapping sediment, although forested buffers provide other benefits as well.

Key Terms

A ***perennial*** stream is a stream or river that flows throughout the year, except during extreme droughts.

An ***intermittent*** stream flows at least six months out of the year—but does not flow during part or all of the summer.

An ***ephemeral*** stream flows less than six months out of the year, and may only carry water during or after a rainstorm.

Trapping/Removing Phosphorus, Nitrogen, and Other Contaminants

Phosphorus and nitrogen can be serious aquatic pollutants because they lead to eutrophication, or over-fertilization, of water bodies. Buffers are effective at trapping limited amounts of phosphorus. In many cases, phosphorus is attached to sediment or organic matter, so buffers sufficiently wide to control sediment should also provide adequate short-term phosphorus control. There are limits, however, to how much phosphorus a buffer can hold, and over the long term the soil can become saturated with the nutrient. For this reason, buffers should not be considered the primary method for controlling phosphorus runoff.

Buffers can provide very good control of nitrogen in runoff. Nitrogen that enters the buffer in the form of nitrate, ammonia, or organic ni-

trogen can be transformed into harmless nitrogen gas by microorganisms, allowing permanent removal of high concentrations of the nutrient. The widths necessary for removing nitrogen vary based on patterns of water flow, soil factors, slope, and other variables. In most cases, 30-meter (100-foot) buffers should provide good control, and 15-meter (50-foot) buffers should be sufficient under many conditions. It is especially important to preserve wetlands, which are sites of high nitrogen removal activity.

Other contaminants, including metals, pesticides, and biological pathogens, can also be trapped by buffers and in some cases transformed into less harmful forms. Although studies are limited, it appears that buffers should be at least 15 meters (50 feet) wide to remove these contaminants, and possibly much wider in some cases.

Protecting Wildlife Habitat

Riparian buffers are an essential component of aquatic habitat. They provide food for aquatic organisms in the form of leaves, debris, and invertebrates; they shade the stream, maintaining moderate water temperatures; and they contribute large woody debris, which adds to habitat diversity. The literature indicates that buffers from 10 to 30 meters (35 to 100 feet) wide are necessary for protecting aquatic habitat, depending on different factors. To be most effective, buffers must be preserved along as many streams as possible and composed of native forest.

Riparian buffers themselves constitute important terrestrial habitat, and the quality is directly correlated with width. While narrow buffers offer considerable habitat benefits to many species, protecting diverse terrestrial riparian wildlife communities requires some buffers of at least 100 meters (300 feet). To provide optimal habitat, buffers should consist of native forest.

Achieving Effective Buffer Extent, Vegetation, and Width

These are the recommendations for riparian buffer extent, vegetation, and width based on the literature review; they have been incorporated into the model ordinance, page 59.

Extent

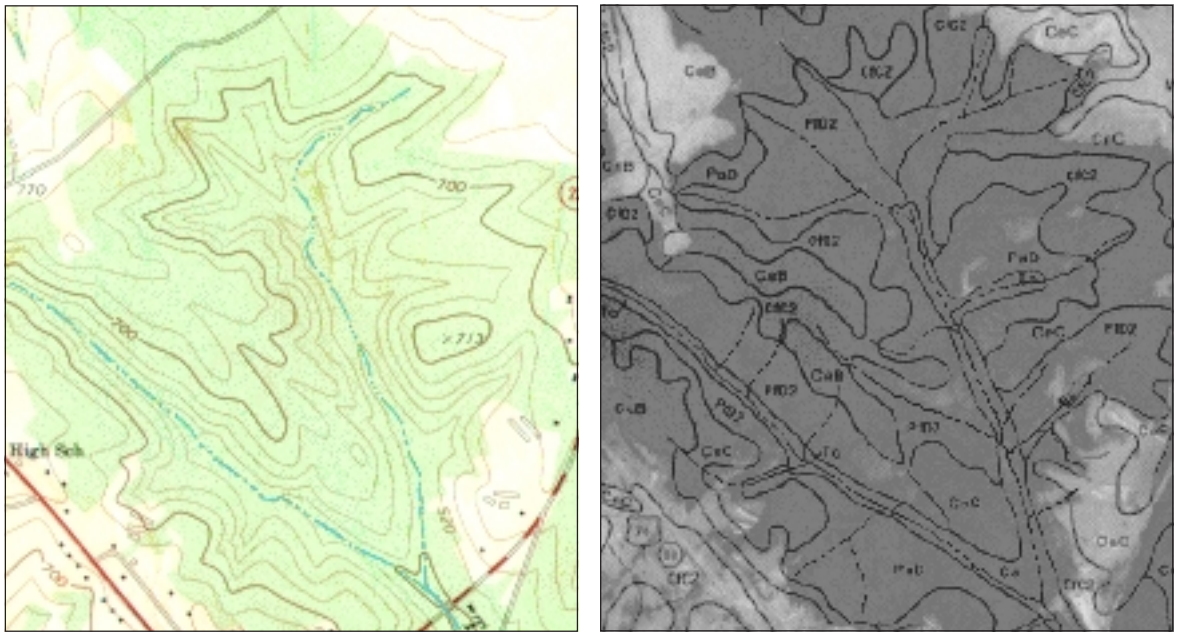
It is very clear that riparian buffers must be preserved on as many stream miles as possible. We recommend that, at a minimum, all perennial and intermittent streams be protected by buffers. To define these streams, local governments should use whatever map type corresponds most closely

to field observations. For many parts of Georgia, the best option is the U.S. Department of Agriculture (USDA) Soil Survey maps, although recent versions are not available for all counties. U.S. Geological Survey (USGS) 1:24,000 scale topographic maps are a less acceptable alternative because they tend to omit many small-order tributaries (see Figure 1). Whichever map type is used, the administering authority for the ordinance should also be allowed to designate additional streams that are deemed worthy of protection, even if they do not appear on Soil Survey maps.

Ephemeral streams should also be protected when possible. However, because there is no lower boundary for the definition of an ephemeral stream—i.e., it is difficult to define what is an ephemeral stream channel and what is just a ditch—we recommend only that the banks of ephemeral channels be vegetated. [Note: Ephemeral streams may be considered streams under the Erosion and Sedimentation Act; therefore, land-disturbing activities may be subject to the restrictions of that law.]

Figure 1. Topographic Maps vs. Soil Survey Maps

These two maps show the same location in the Georgia Piedmont. The map on the left, a USGS topographic map, does not show many of the small intermittent streams that appear on the USDA soil survey map at right.



Vegetation

A riparian buffer covered by grass can adequately perform several functions, including trapping sediment and contaminants. However, effective performance of all functions, including protection of aquatic habitat, requires forested buffers. Therefore, we recommend that riparian buffers be preserved in a naturally vegetated state consisting of native forest. Restoration should be conducted when necessary.

Width

The literature review showed that most scientific recommendations for minimum buffer widths range from 15 meters (about 50 feet) to 30 meters (about 100 feet). It might be possible to determine the correct width from within this range by conducting additional research in the region of interest. Such research would be expensive and time consuming, however, and most local governments do not have funds for research or the time to wait for the results. In most cases, then, the choice of minimum width becomes a choice between margin of safety and acceptable risk. The greater the minimum buffer width, the greater the margin of safety in terms of water quality and habitat preservation. Accordingly, three options are proposed. The first is a variable-width buffer with a 100-foot base width, the second is a variable-width buffer with a 50-foot base width, and the third is a fixed-width buffer of 100 feet. The first can be considered the "conservative" option: it meets or exceeds many scientific buffer width recommendations; and, therefore, should ensure high water quality and support good habitat for native aquatic organisms. The second and third options are "riskier": they should, under most conditions, provide good protection to the stream and good habitat preservation, although heavy rain, floods, or poor management of contaminant sources could more easily overwhelm the buffer. All of these options are defensible given the literature reviewed. In choosing an option, government officials and other stakeholders must decide how much risk they can tolerate in the preservation of their aquatic resources.

Option One (variable width)

- Base width is 100 feet (30.5 meters) plus 2 feet (0.61 meters) per 1 percent of slope* of the stream valley.
- It is extended to edge of floodplain.

*Percent slope is the increase in elevation per unit of width. For example, if the stream valley rises by 20 feet over a width of 100 feet, slope is 20 percent.

- It is extended by the width of wetlands that lie within or partly within the buffer (as determined by slope and floodplain width).
- Existing impervious surfaces in the riparian zone do not count toward buffer width (i.e., the width is extended by the width of the impervious surface, just as for wetlands).
- Slopes over 25 percent do not count toward the width.
- The buffer applies to all perennial and intermittent streams.
- Ephemeral streams are not protected by buffers, but their banks must be vegetated.

Option Two (variable width)

- Base width is 50 feet (15.2 meters) plus 2 feet (0.61 meters) per 1 percent of slope of the stream valley.
- Entire floodplain is not necessarily included in the buffer, although potential sources of severe contamination should be excluded from the floodplain.
- Existing impervious surfaces in the riparian zone do not count toward buffer width (i.e., the width is extended by the width of the impervious surface, just as for wetlands).
- Slopes over 25 percent do not count toward the width.
- The buffer applies to all perennial and intermittent streams.
- Ephemeral streams are not protected by buffers, but their banks must be vegetated.

Figure 2 illustrates how Option Two is applied.

Variable-Width vs. Fixed-Width Buffers

Any of the three buffer options presented here would be a reasonable, scientifically defensible alternative for a local government in Georgia. Variable-width options, however, offer some significant benefits over fixed-width buffers. First, they are more scientifically defensible and more likely to provide adequate but not excessive protection. The variables that were used in the width formulas (slope, presence of wetlands, width of floodplain, and presence of impervious surfaces) were selected because they are highly correlated with buffer effectiveness and are easily measured in the field. Fixed-width buffers may not provide sufficient protection to ecologically sensitive areas or, conversely, may deprive landowners of areas more suited to development in ecological terms (Herson-Jones et al. 1995). Second, areas with different characteristics require different degrees of protection. Third, variable-width buffers can incorporate protection for other sensitive natural features such as floodplains, steep slopes, and wetlands. They do, however, have some potential drawbacks: they require slightly more staff time to administer, are less easily understood by the public, and may strike some landowners as unfair.

Option Three (fixed width)

- Fixed buffer width is 100 feet.
- The buffer applies to all perennial and intermittent streams.
- Ephemeral streams are not protected by buffers, but their banks must be vegetated.

For all three options, buffer vegetation should consist of native forest. Restoration should be conducted when necessary and possible.

Prohibited Activities

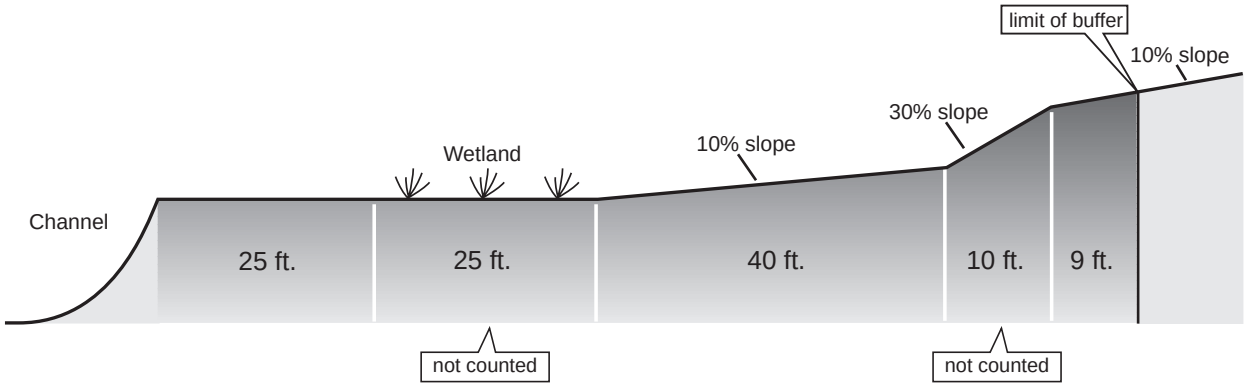
All significant sources of aquatic contamination and degradation should be excluded from buffers. These include construction resulting in land disturbance, impervious surfaces, logging roads, mining, septic tank drain fields, agricultural fields, waste disposal sites, stormwater detention ponds (except those designed as wetlands), access of livestock, and clear cutting of forests. Application of pesticides and fertilizers should also be prohibited.

Providing Additional Wildlife Habitat

All of the buffer options described above will provide habitat for many terrestrial wildlife species. To provide habitat for forest interior species, at least some riparian tracts 300 feet or wider should also be preserved. Identification of these areas should be part of an overall, countywide wildlife protection plan.

Figure 2. Applying a Flexible-Width Buffer

This diagram illustrates how Buffer Option 2 is applied to a hypothetical landscape. The average slope of the stream valley here is 12 percent, which means the buffer should be 50 + 24 = 74 feet wide. The width of the wetland and the steep slope are added to the total width, so the buffer actually covers some 109 feet. If an impervious surface were present, its width would also be added to the total.



Effective Buffer Ordinances

A Selective Review

A number of Georgia counties and municipalities have established stream buffer ordinances. Most of these are modeled directly on EPD minimum standards, while others are more restrictive and a few even innovative. This section briefly presents several of the ordinances that exceed or differ from the minimum standards. It also describes a small sampling of local buffer protection programs from other states, primarily in the Southeast. Concluding the section are some results from a far more thorough survey of 36 local and state riparian buffer programs conducted by Heraty in 1993 (Schueler 1995).

Alpharetta

The city of Alpharetta maintains 100-foot buffers on all perennial streams as a requirement of its Erosion and Sedimentation Ordinance. According to Dee West, Director of Environmental Services, there was virtually no opposition to the buffer requirement because developers and the general public were invited to participate from the beginning of the ordinance development process (1998). The Alpharetta ordinance allows flexibility in buffer width, as long as a minimum of 50 feet and an average of 100 feet in width is maintained. In addition, there is an impervious surface setback that must average 150 feet in width and cannot be less than 75 feet in width. Septic tanks and septic tank drain fields are prohibited in this zone.

According to West, the only major enforcement difficulty the city experiences is that the EPD retains sole authority to issue variances for the riparian buffer requirements of erosion and sedimentation ordinances. Although Alpharetta rarely issues variances for the buffer requirements, the EPD routinely issues such exceptions. This is a potential drawback to buffer ordinances that only specify erosion and sedimentation control as the purpose of riparian protection.

Douglas County

Douglas County, Georgia, developed stream corridor zones in 1976 to protect the Dog River and Bear Creek basins, which serve as the county's public water supply (Dean 1997). With some revisions, these regulations are still part of the county's zoning code. There are actually three distinct classifications of stream corridors, two of which are independent zones and one of which is an overlay zone.

The Reservoir Open Space (ROS) zone protects the Bear Creek and Dog River Basins. Both rivers and all of their tributaries are protected by

a 100-foot buffer of undisturbed natural vegetation, in addition to a 200-foot to 300-foot setback for construction (except wells), septic systems, and for maintaining animals. Moreover, there is a wider zone of 250 feet (small tributaries), 500 feet (large tributaries), or 1,000 feet (Bear Creek and Dog River mainstem) from the stream in which there can only be one house per five acres. Commercial, industrial, and high-density residential uses are prohibited.

...Each parcel within the Reservoir Drainage Basin-Open Space district, an overlay zone, is subject to its restrictions as well as the zone it lies within.

The Open Space (OS) district is a subzone that can be established along other streams and rivers upon the recommendation of the county engineering department. The zone, which may be from 100 feet to 1,000 feet wide, also limits development to one house per five acres. The Reservoir Drainage Basin-Open Space (RDBOS) district is an overlay zone; i.e., each parcel within the RDBOS district is subject to the restrictions of both the RDBOS and the other zone it lies within. It does not follow stream corridors but rather serves to limit development on sensitive upland areas within the Bear Creek and Dog River basins. It is less protective than the ROS and OS zones: within the district, housing density is restricted to one unit per acre (for unsewered areas) or one dwelling unit per 30,000 square feet for areas served by sewers. Commercial development is likewise restricted to parcels of one acre or larger except in areas served by sewers (Douglas County Board of Commissioners 1998).

Fulton County

In September 1998, Fulton County passed an ordinance to establish protected stream corridors for the unincorporated southern portion of the county. The impetus for the ordinance was twofold. First, Fulton County sought to expand the Camp Creek Wastewater Treatment Plant to compensate for the increased pollution, and the Georgia EPD required the county to reduce nonpoint pollution. Second, the Metropolitan River Protection Act (MRPA) was amended so that as of July 1, 1998, the protected zone along the Chattahoochee River was extended from Peachtree Creek (where it previously terminated) to the southwest border of Fulton County (Fulton County Board of Commissioners 1998). The MRPA requires buffers of 50 feet on the mainstem of the Chattahoochee River, 35-foot buffers on tributaries within 2,000 feet of the Chattahoochee, and 25-foot buffers on all other tributaries of the river (Cowie and Hardy 1997). Fulton County decided to exceed these minimum requirements by establishing a 75-foot-wide natural vegetated buffer on all perennial streams, with an additional 15-foot impervious surface setback and a further 10-foot-wide "improvement setback."

The ordinance effectively establishes an overlay zone on properties in the stream corridor, imposing additional restrictions in addition to those required by the primary zone. Within the protected corridor, which totals 100 feet in width, the following are prohibited:

- Septic tanks and septic tank drain fields
- Receiving areas for toxic or hazardous waste or other contaminants
- Hazardous or sanitary waste landfills
- Stormwater retention or detention facilities
- Accessory structures and buildings, parking lots, driveways, and other impervious surfaces

Utilities and transportation uses may be located within the corridor if a feasibility study is conducted to examine alternatives and if the project follows appropriate best management practices (BMPs) and will not diminish water quality. Timber harvesting is permitted except within 35 feet of the stream. Existing land uses are exempted, but no additions may be made to buildings and structures that sustain greater than 60 percent damage may not be rebuilt (Fulton County 1998).

The Fulton County ordinance has several interesting and significant aspects. First, it greatly exceeds state-mandated minimum requirements in a way that reflects scientific understanding of stream corridors. Second, in addition to the streams that appear as blue lines on United States Geological Survey (USGS) 7.5 minute topographic maps, protection may be applied to other perennial streams identified by Fulton County. The ordinance does not, however, protect intermittent or ephemeral streams; and this may reduce its effectiveness. Third, the ordinance does not exempt mining and other activities that may harm water quality, but which are sometimes exempted for political reasons. Finally, the ordinance provides clear and detailed rules for granting variances.

Madison County

Madison County passed a stream corridor protection ordinance in 1995 to protect the Broad and Hudson Rivers through creation of an overlay zone. Requirements are consistent with the minimum standards set forth by the Georgia Mountain and River Corridor Protection Act in nearly all respects, except that surface mining is specifically prohibited.

Winston–Salem/Forsyth County, North Carolina

Through ordinances established in the 1980s and 1990s, the city of Winston–Salem and Forsyth County, North Carolina, established a comprehensive watershed plan for Salem Lake, which provides 42 percent of the water

supply for the region. As part of the plan, 100-foot-wide protected stream corridors were established along all perennial streams in the watershed. The only types of development permitted in the stream corridor are water-dependent structures, transportation infrastructure, utilities, and passive recreation structures. Land-disturbing activities are prohibited within 25 feet of the stream (Tyler et al. 1998).

Greensboro, North Carolina

On March 17, 1999, the Greensboro City Council approved a stormwater management ordinance that included riparian buffer provisions for all streams and natural channels draining at least 50 acres. The buffer consists of two zones: (1) a 15-foot-wide zone that is free of any development or soil disturbance and (2) a 35-foot-wide (or wider) zone that is free of occupied structures and has an impervious surface coverage of less than 50 percent. According to a University of North Carolina biologist (Rublee 1999), the buffer specifications were established through compromise among "developers" and "environmentalists." The primary purpose of the ordinance is to prevent flooding, rather than to provide water quality or habitat benefits.

Chester County, South Carolina

In 1994, South Carolina passed the Comprehensive Planning Act. It required counties that currently have zoning ordinances and comprehensive planning (a little more than half of the state's 46 counties) to update their plans and address natural resource protection by May, 1999. As a result, a number of local governments in the state are expected to develop stream corridor protection ordinances or zoning districts (Beasley, South Carolina Department of Natural Resources, 1998).

South Carolina's 1994 Comprehensive Planning Act required that counties with zoning ordinances and comprehensive planning update them and address natural resource protection by May 1999.

At this time, only two local governments have successfully introduced stream corridor zoning: Chester County and the city of Rock Hill. In 1998, Chester County adopted a zoning ordinance and shortly thereafter added a river preservation district, not as an overlay but as an independent zone. The district extends 100 feet on either side of the Catawba and Broad Rivers and 50 feet on either side of designated tributary streams. The only uses permitted in the river preservation zone are

- passive recreation;
- public boat landings, public water or wastewater treatment facilities, intakes, discharges, or other public uses; and
- agriculture and silviculture to include watering of livestock, tilling, and tree harvesting among other activities, provided any disturbed soil is maintained on-site until the buffer is revegetated.

No private structures may be built in the zone, and housing within the buffer cannot be rebuilt if it is more than 50 percent damaged. Some members of the agricultural community expressed concerns about the establishment of the zone, but once they were assured that agricultural practices would still be permitted, opposition evaporated. The commissioners voted unanimously to pass the measure (Vead, Catawba Regional Planning Council, 1998).

Rock Hill, a city in York County, South Carolina, has established a 150-foot naturally vegetated buffer along the Catawba River. York County also attempted to establish a 100-foot riparian buffer through a free-standing river corridor ordinance, but the proposal failed at its second reading (three readings are required). Problems may have arisen because the proposed ordinance imposed some additional, although minor, restrictions in a 200-foot zone beyond the buffer, which apparently led to confusion and opposition among landowners who interpreted it as a 300-foot naturally vegetated buffer (Vead 1998).

Brown County, Wisconsin

Many local governments are understandably reluctant to impose regulations on the agricultural community, but a few counties have found it necessary and feasible to do so. One of these is Brown County, Wisconsin. In January 1998, the Brown County Board of Supervisors passed an ordinance establishing a 300-foot "agricultural shoreland management area" on all perennial and intermittent streams and rivers. Within this corridor, agricultural practices must be consistent with NRCS guidelines and erosion must be limited. Additionally, a 20-foot-wide vegetated buffer must be established along the banks of streams. Row cropping and tillage are prohibited in the 20-foot-wide buffer, although the land may serve as pasture if it meets technical guidelines (Brown County Board of Supervisors 1998).

Many local governments are reluctant to impose regulations on the agricultural community.

Charles County, Maryland

Charles County protects riparian buffers through a variable-width zoning district. The minimum width is based on the 100-year floodplain and is extended by the width of nontidal wetlands, plus 50 feet for 1st and 2d order streams and 100 feet for 3d order or larger streams.

When a 100-year floodplain and wetlands are not present, width is either 50 feet or 100 feet depending on stream order. In addition, if the slope of the stream valley is greater than 15 percent, the width of the buffer is doubled or extended to the top of the slope (whichever is less). Furthermore, the Charles County Planning Commission has the authority to ex-

tend the buffer to include important features. The complexity of the program makes it more difficult to administer than a fixed-width buffer. Because the buffer is a dedicated zoning district, changes to buffer width are considered changes to the zoning map and may only occur twice a year (Maryland Office of Planning 1993).

1993 Survey of Buffer Programs

In 1993, Heraty surveyed some 36 state and local urban riparian buffer programs nationwide. Responses indicated that protected buffers ranged in width from 20 feet to 200 feet, with an average of 92 feet. Sixty-five percent of the programs had variable-width buffers that extended width for slope (34 percent), certain classifications of streams/water bodies (15 percent), floodplain (8 percent), wetlands (12 percent), size of stream or water body (3 percent), type of development (6 percent), or some other condition (21 percent).

Eighty-six percent of the buffers required vegetation and limited disturbance of the buffer area. Sixty-six percent required vegetation to remain unaltered from predevelopment condition. Only 6 percent of programs permitted logging, although tree trimming, mowing, and tree removal were permitted by many programs. The restrictions on tree cutting no doubt reflect the urban focus of the survey.

Heraty reported that most buffer programs had strong citizen support. Over 80 percent of local governments agreed with the statement, "a majority of our citizens think that the community is better off having stream buffers." Ninety-four percent believed that buffers had a neutral or positive effect on adjacent land values.

Based on this survey, Schueler (1995) identified eight key points about riparian buffers:

1. *Buffer boundaries are largely invisible to local governments, contractors, and residents.* To be protected, buffers must be indicated on construction plans and marked at construction sites. Property owners must be informed of the presence and boundaries of buffers.
2. *Buffers are subject to extensive encroachment in urban areas.*
3. *Few jurisdictions have effective buffer education programs.*
4. *Allowable and unallowable uses are seldom defined.*

Points two, three, and four emphasize the need to communicate clearly with landowners about the boundaries of buffers, the benefits of buffers, and the permissible uses of buffers.

5. *Few jurisdictions specified mature forest as a vegetative forest.* Schueler notes that "given the importance of riparian forests to the ecology of headwater streams, the adoption of a specific vegetative target for the stream buffer would be wise."
6. *Accuracy of buffer delineation is seldom confirmed in the field.* Heraty's study found that 50 percent of the buffer programs reported problems in buffer measurement by consultants. Twenty percent lacked a mechanism to inform the contractor about buffer boundaries during construction.
7. *Most buffers remain in private ownership.* Ninety percent of the buffers remained privately owned after development. Only 10 percent were acquired by the municipality or other government entity.
8. *The stream buffer program needs to be responsive to the interests of the development community.* This does not mean that buffer ordinances were necessarily too strict. Most developer concerns were directed at administration of the program rather than the restrictions in the buffer ordinance itself. This again suggests the need for open communication between the administrative agency and the developers and landowners who are impacted by the ordinance.

Tools to Protect Riparian Buffers

This section outlines the regulatory and nonregulatory tools that are available to local governments for protecting riparian buffers. In the first part, different types of riparian buffer ordinances are described. The second part outlines some related regulatory tools that can be used to support the riparian buffer ordinance. The final part describes nonregulatory approaches to riparian buffer protection, which are useful means of preserving land that is excepted from a riparian buffer ordinance.

Forms of Riparian Buffer Ordinances

Overlay Zoning Ordinances

For a county that already has a zoning ordinance in place, the most effective and expedient way to protect riparian buffers is through an amendment that adds a riparian buffer overlay zone. An overlay zone imposes restrictions on the affected portion of a property in addition to the restrictions placed on the property as a whole by the underlying zoning classification. It does not require changes to the current zoning map. Some local governments (e.g., Douglas County, Georgia; Chester County, South Carolina; and Charles County, Maryland) have used dedicated stream corridor zones rather than overlay zones. With this approach, a single property is split into two zoning districts—a riparian buffer zone district and the conventional zoning district. The model riparian buffer ordinance included at the end of this paper specifies overlay zones.

The model ordinance included at the end of this paper specifies overlay zones.

Freestanding Ordinances

For counties that do not have a zoning ordinance, a separate stream corridor protection ordinance is necessary. Several such ordinances were described in the preceding review of ordinances currently in place. However, because local governments are delegated specific zoning powers by the Georgia Constitution, they may have more flexibility in developing zoning-based riparian buffer ordinances than free-standing ordinances. For more information, see the section on "Meeting Minimum Standards," page 29.

Floodplain Protection Ordinances

A floodplain protection ordinance can be a reasonable mechanism for riparian buffer protection. Historically, however, most floodplain ordinances are intended to minimize property damage, not to protect the ecological functioning of the floodplain or the river. There is now growing recogni-

tion among government agencies that floodplains should be managed in a way that preserves their natural ecological functions:

> "Rivers and their floodplains are dynamic and complex natural systems that can provide important societal benefits, both economic and environmental. By adapting to the natural phenomenon of flooding, rather than trying to control floodwaters, we can reduce the loss of life and property, protect critical natural and cultural resources, and contribute to the sustainable development of our communities." (Federal Interagency Floodplain Management Task Force 1996)

The EPD Floodplain Management Office encourages local governments to include natural resource protection in drafting their floodplain ordinances (Brock, Environmental Specialist, 1998). Ideally, riparian buffers should be extended to the width of the floodplain, as proposed in riparian buffer width Option One, on page 11. At a minimum, local governments should incorporate language into their Flood Damage Prevention Ordinances to acknowledge the importance of preserving natural floodplain processes and to prohibit certain activities and structures that could cause serious environmental harm. These include animal waste lagoons, hazardous and municipal waste receiving and disposal sites, application of pesticides, and land application of animal waste or fertilizers. Because enforcement of such an ordinance would be difficult, compliance should be encouraged through a public information campaign.

Auxiliary Ordinances

Erosion and Sedimentation Control Ordinances

Local governments that have their own erosion and sedimentation control ordinances can be delegated the authority to administer the Erosion and Sedimentation Act of 1975 within their jurisdiction. This ordinance acts, in effect, as a buffer ordinance protecting a 25-foot (minimum) stream corridor on all streams and a 100-foot corridor on primary and secondary trout streams. Local officials are also authorized to pass ordinances that are more restrictive than the specifications of the state law. In the past, some local authorities have found difficulties in enforcing this ordinance because the EPD retains sole authority for issuing variances to the buffer provisions. The experiences of the city of Alpharetta were described in the previous section. While it can be argued that the local authority can overrule an EPD variance if it wishes, this legal issue can be avoided if the ordinance is properly worded to specify that buffers are protected for multiple purposes, not just erosion and sedimentation control.

Regardless of how buffers are protected, a properly enforced erosion and sedimentation control ordinance is essential in reducing the sediment in runoff and enhancing the performance of buffers. Riparian buffers alone are not enough to mitigate the effects of otherwise uncontrolled upland activities (Binford and Buchenau 1993). A broader approach of using various best management practices is more effective. As Barling (1994) notes, "Buffer strips should only be considered as a secondary conservation practice after controlling the generation of pollutants at their source." In many cases it may be easier, cheaper, and preferable to prevent sediments from mobilizing and moving off-site in the first place. For agriculture and forestry, soil is a valuable asset that is extremely difficult to replace. Erosion reduction efforts should focus on keeping soil in fields, where it is usable, rather than trapping it after it has left a field, where it is much more difficult to salvage. Numerous agricultural best management practices (BMPs) have been developed for this purpose. Producers should be strongly encouraged to implement the most effective BMPs, in addition to preserving riparian buffers. Additional information on BMPs and financial incentives for their use is available from the Natural Resources Conservation Service and the Georgia Soil and Water Conservation Commission.

For agriculture and forestry, soil is a valuable asset that is extremely difficult to replace.

Likewise, BMPs must be faithfully implemented and enforced in construction projects. A review by Brown and Caraco (1997) found that in many cases, half of all practices specified in erosion and sedimentation control plans were not implemented correctly and were not working. Contractors habitually saved money by cutting ESC installation and maintenance. Surveys also found that ESC practices rated as "most effective" by experts were seldom applied while those rated "ineffective" are still widely used. Further, a field assessment of silt fences found that 42 percent were improperly installed and 66 percent were inadequately maintained. While a substantial amount of money is now spent on ESC practices, Brown and Caraco (1997) concluded that "much of this money is not being well spent —practices are poorly or inappropriately installed, and very little is spent on maintaining them."

Effective enforcement of erosion and sediment control laws requires water quality monitoring and evaluation against a scientific standard. In 1996, a panel of scientists convened to make recommendations to the Georgia Department of Natural Resources (DNR) proposed establishing a turbidity standard of 25 NTU (nephelometric turbidity units), measured at the end of designated stream segments (Kundell and Rasmussen 1995). We recommend that local governments establish 25 NTU as a performance standard to monitor whether erosion and sedimentation control BMPs and riparian buffers are effective in controlling sedimentation in different stream segments. To pay for monitoring, a fee could be added to the erosion and sedimentation control permit application.

Impervious Surface Limits

Riparian buffers cannot protect a stream from channel erosion if it is constantly scoured by high storm flows caused by runoff from impervious surfaces. In addition to protecting stream corridors, we strongly recommend that local governments pass an ordinance to minimize impervious surfaces and we encourage use of alternatives. There is solid scientific justification for such limits. In a natural forested watershed, surface runoff is quite rare, occurring only during the most severe rainstorms. Impervious surfaces, on the other hand, transfer most precipitation into runoff, leading to increased surface erosion, higher and faster storm flows in streams, and increased channel erosion. As a consequence, urban streams characteristically have greatly elevated sediment levels (Wahl et al. 1997). Flow from impervious surfaces also carries pollutants directly to streams, bypassing the natural filtration that would occur by passage through soil. Impervious surfaces are so closely correlated with urban water pollution that they are commonly used as an indicator of overall stream quality (Arnold and Gibbons 1996). May et al. (1997) note that impervious surfaces are the "major contributor to changes in watershed hydrology that drive many of the physical changes affecting urban streams." Trimble (1997) ascribed the cause of large-scale channel erosion in San Diego Creek to increased impervious surfaces in the watershed.

By transferring most precipitation into runoff, impervious surfaces lead to increased surface erosion…and increased channel erosion.

A stream may be considered to be impacted when more than 10-12 percent of its watershed is covered by impervious surfaces; when impervious surface levels reach 30 percent, the stream can be considered degraded (Klein 1979). While maintaining protected riparian buffers helps to stabilize banks and otherwise mitigate the effects of impervious surfaces, in many urban areas "as much as 90 percent of the surface runoff generated in an urban watershed concentrates before it reaches the buffer, and ultimately crosses it in an open channel or an enclosed storm drain pipe" (Schueler 1995). In these cases, buffers have little opportunity to intercept sediments and other pollutants carried to the stream (Note, however, that many studies have shown a good correlation between urban riparian buffers and water quality; e.g., May et al. 1997). Therefore, to protect streams in urban areas and to allow riparian buffers to properly perform their functions, it is necessary to minimize impervious surfaces across the whole watershed.

There are numerous ways in which local governments can reduce impervious surfaces and encourage the use of alternative, porous materials. These include the following:

- Relaxation of design standards that mandate excessive impervious surfaces. Minimum road widths are reduced, minimum parking re-

quirements are lowered, and grassed swales are allowed as an alternative to concrete gutters.

- Smart Growth provisions that encourage clustered development. Development that is concentrated in a few areas creates less impervious surface area than sprawl.
- Use of pervious materials in government projects.
- Incentives for the use of pervious materials. Developers who use pervious alternatives or otherwise reduce impervious surface area are offered financial incentives.
- A stormwater utility fee. Developers are charged a fee based on the impervious surface area of new development to cover the impacts of increased stormwater generation. This acts as a disincentive for impervious surfaces.
- Impervious surface limits. The most comprehensive approach is to place actual limits on the amount of impervious surfaces that may be used on a site, in a watershed, or in a region.

According to Dr. Bruce Ferguson of the University of Georgia School of Environmental Design, it is possible to virtually eliminate impervious surfaces using existing technologies (1998). In addition to the water quality benefits, reducing impervious surfaces also can save a great deal of money—directly in construction costs and indirectly in flood mitigation (Arnold and Gibbons 1996). Appendix B lists various publications that discuss this topic further.

Nonregulatory Riparian Buffer Preservation Tools

A riparian buffer ordinance can be supplemented with a number of nonregulatory programs to increase its effectiveness and acceptance by landowners. Transferable development rights and density transfers provide a mechanism for compensating landowners who are affected by a buffer ordinance. Conservation easements and acquisition are ways to protect properties that are not affected by the ordinance. Conditional-use rezoning and developer exactions can increase the scope of the ordinance through additional requirements for developers. All of these are described in more detail here.

Transferable Development Rights

A local government that is serious about protecting water quality needs to look at the overall pattern of development in its jurisdiction. Not only does unplanned development adversely affect water quality, the cost of providing government services to sprawling development is very high. An essential tool for managing growth is a transferable development rights (TDR) program. In a TDR program, some areas are designated for preser-

vation and low-density development, and others are marked for high-density development. The low-density areas—called "sending zones"—can be the more environmentally sensitive regions (or they may be the locations of agricultural production), while the high-density areas—"receiving zones"—are areas where it is most most cost-effective to provide services and provide infrastructure. Property owners in the receiving zones are allowed to buy development rights from property owners in the sending zones. Once the development right is sold from a sending property, that parcel may never be developed (in fact, it is usually protected from development by a permanent conservation easement). The owner of the receiving parcel can use those development rights to develop more densely and, presumably, more profitably.

Although TDRs appear complicated at first, they represent an invaluable mechanism, for equitably distributing the costs and benefits of development. Transferable development rights are a means of compensating landowners who are in low-density zones. Without TDRs, local officials will constantly face pressure to upzone properties to allow greater development, whether or not such development is in an appropriate location.

TDRs are invaluable in distributing the costs and benefits of development.

TDRs should be used in concert with overlay zoning or a freestanding stream corridor ordinance. It is possible to designate all protected stream corridors as "sending areas," which would provide potential compensation for all impacted landowners. However, because this would create a market with hundreds or thousands of landowners holding a relatively small number of TDR credits apiece, this would only be practical if an effective TDR banking system were established. Floodplain areas that are not protected within riparian buffers should be classified as sending areas. Additionally, local governments should identify some wide (300 feet or greater) stream corridors that merit preservation as terrestrial wildlife habitat and designate these sites as sending areas.

Density Transfers

Density transfers are similar to TDRs in that they allow more dense development in one area in exchange for preservation of another area, but they are used to transfer development *within* a property rather than between properties. This can be used to compensate developers for the loss of land protected in the stream buffer by allowing them to develop more densely in the remainder of the property. A TDR ordinance can be written in such a way as to allow density transfers as a special type of TDR. Density transfers are also a common component of conservation subdivision regulations.

Conservation Easements

Regardless of the other stream corridor tools employed, conservation easements can be a useful mechanism for preserving tracts of riparian lands. Conservation easements are agreements in which landowners voluntarily agree to give up some of their development rights in exchange for tax benefits. Conservation easements require little oversight and virtually no expense on the part of the local government. On the other hand, initial participation of landowners is voluntary and therefore somewhat unpredictable. Many local land trusts are capable of accepting and enforcing conservation easements, sparing local governments the burden of handling paperwork and monitoring protected tracts.

Local governments can encourage the donation of conservation easements in several ways. First, they can establish a timely schedule for reassessing properties once easements have been donated, to provide landowners with property tax relief. Second, they can work with local land trusts to identify priority areas in which easements are most desirable. Third, they can promote the donation of easements through public information campaigns. Fourth, they can include a statement in their comprehensive plan or zoning ordinance that preserving riparian lands is in the public interest. This makes it easier for landowners to claim federal income tax deductions for placing conservation easements on their properties. (See Appendix B for further information sources on conservation easements.)

Acquisition

Acquisition is sometimes the best mechanism for protecting key parcels of land in the stream corridor. Generally, acquisition is reserved for special cases and cannot be the sole method for protecting riparian buffers. There are numerous sources of funds that can be applied toward riparian land acquisition. They are as follows:

- *Clean Water Act Section 319.* Funds for nonpoint source pollution control. Priority goes to watersheds ranked highly in Georgia's Unified Water Assessment Process (GA DNR EPD 1998).
- *The Heritage Fund.* Although this constitutional amendment failed in November, 1998, it will likely reappear at some point in the next few years. In its 1998 version, this amendment would have added $1.00 (on every $1,000 of home value) to the real estate transfer tax to create a fund dedicated to preservation of natural and historic sites. It is estimated that the fund would provide $30 to $32 million annually.
- *Georgia Environmental Facilities Authority.* This program, administered by the Department of Community Affairs, offers low-inter-

est loans and grants for various purposes, including nonpoint source pollution control.

- *Impact Fees.* Local governments are authorized to charge fees to developers to pay for the infrastructure necessary to support the development (O.C.G.A. § 36-71-1 et seq). These fees can be applied to protect and produce water supplies, acquire and protect parks and open space, protect and improve shores (stream banks), and provide for flood control, among other purposes (Billingsley and Mizerak 1997).

An Effective Buffer Ordinance: The Components

An effective riparian buffer ordinance is the product of careful forethought. This section discusses some of the components that should be included in a riparian buffer ordinance. The model ordinance, Appendix A, provides an example for incorporating these guidelines into practice. Practical issues related to the administration and enforcement of a riparian buffer ordinance are also discussed here.

Meeting Minimum Standards

Local governments with water supply watersheds and large rivers within their jurisdictions must comply with the appropriate minimum standards issued by the EPD. If local governments choose to develop buffer ordinances that differ from the minimum standards, they must petition for EPD approval of alternate criteria. The model ordinance (Appendix A) is designed to meet the relevant minimum standards, except for one aspect. The minimum standards for river corridor protection, under the Mountain and River Corrider Protection Act, *prohibit* local governments from restricting construction of single family homes within the riparian buffer. While the proposed buffer ordinance provides an exemption for single family homes, it requires that they be located outside the buffer area if possible. This technically violates the minimum standards. For local governments with zoning, however, this may not be a problem. The local zoning powers established under the Georgia Constitution should allow local governments to supersede the restriction of the minimum standards in this respect. Nevertheless, this has never been legally tested, and local governments should still petition the EPD to allow this variation. Local governments without zoning ordinances may have less ground for using alternate criteria. In that situation, a standalone ordinance may have to comply precisely with the minimum standards and fully exempt single family homes from all buffer restrictions.

The model ordinance, Appendix A, includes the components discussed in this section.

In addition to buffer requirements, the minimum standards for water supply watersheds compel local governments to impose other restrictions, such as impervious surface limits. Local governments affected by these minimum standards must either add a new provision or enact a separate ordinance to meet these requirements. (See model ordinance, Appendix A, for more details.)

Flexibility and Variance Procedures

Ensuring a degree of flexibility in delineating riparian buffers is an important strategy when creating an ordinance. It is very likely that cases will arise in which it is necessary and ecologically defensible to reduce the buffer width at certain points. This can be addressed by building a system of buffer averaging into the ordinance. This allows the buffer width to be reduced at certain points as long as the average buffer width remains the same along a parcel. Buffer averaging is incorporated into the attached ordinance as "Minor Exceptions." Buffer averaging would be inappropriate for a fixed buffer of less than 75 feet minimum width, because a reduction would bring the buffer to an unacceptably low level.

Although buffer averaging will address many concerns, in some cases landowners will need to request a formal variance from the provisions of the buffer ordinance. It is essential to clearly establish the conditions under which a variance may be issued. A variance should be considered in two cases:

1. When the buffer encroaches on a parcel to the degree that the remaining land is too small for the property owner to make reasonable economic use of it. In other words, there are grounds for a takings lawsuit. In this case, the buffer should be reduced only as much as necessary to allow for reasonable activity, and never less than 25 feet.
2. When the property is too small for the landowner to construct a single family dwelling without encroaching on the buffer. Again, the buffer should be reduced only as much as necessary to allow for the construction of an average-sized home for a single family.

An appeals process should be established to provide recourse to landowners in the event that a variance request is denied.

Exceptions and Prohibitions

Local governments can, as shown in the model ordinance, make an exception for existing land uses. These are defined as uses that, prior to the effective date of the ordinance, are either completed, ongoing (as in the case of agricultural activity), under construction, fully approved by the governing authority, or the subject of a fully completed application for any construction-related permit that has been submitted for approval. However, an existing use that occurs in the parcel but not currently in the buffer should not be exempted. For example, an agricultural operation that does not currently use the riparian area could not plant the area, spread manure, allow grazing, or otherwise use the corridor in nondesignated ways after the law takes effect.

Normal repairs, restoration, and renovation may be performed upon structures in the stream corridor, but expansion of buildings or impervious areas should be prohibited. Any work that involves disturbance of soils should be subjected to rigorous enforcement of the Erosion and Sedimentation Ordinance. Local governments may also wish to consider prohibiting the reconstruction of buildings that have suffered severe damage. This is not included in the proposed ordinance but is a part of some riparian buffer regulations.

Forestry activities can be permissible on a limited basis. No logging should occur within 50 feet of the stream. No logging roads may be built within the buffer, and buffer crossings should follow the latest best management practices (BMPs) issued by the Georgia Forestry Commission. There are substantial differences between the new and the 1995 BMPs (Georgia Forestry Commission 1995, 1999).

Agricultural operations constitute a special concern because they are often sources of water contamination and have been traditionally exempted from many land-use regulations. Because such operations are generally existing uses, they are also exempted from the proposed ordinance. However, protecting water quality requires addressing issues such as cattle watering in streams and the land application of waste from concentrated animal feeding operations (CAFOs). It is therefore recommended that certain agricultural activities be banned from the floodplain because they pose a direct threat to water quality, even though they may have preexisted. These include application of fertilizers and pesticides, the spreading of animal wastes, and the construction of waste lagoons. Other activities, such as allowing cattle direct access to the stream, should be discouraged and restricted but not necessarily banned.

There are numerous programs to help farmers preserve riparian buffers.

On the positive side, the Natural Resources Conservation Service (NRCS) administers several programs to assist farmers in preserving riparian buffers. The Conservation Reserve Program (CRP), which provides incentives for farmers to retire erodible or sensitive lands, now targets 4 million acres for the establishment of riparian buffers (USEPA 1998). This program has been underused in Georgia, with less than 1,000 acres of buffer land enrolled, compared to more than 15,000 acres in South Carolina (Johnson 1999). The Wetlands Reserve Program (WRP) pays farmers the appraised value of wetland acreage, as well as all costs of restoration, if they place permanent conservation easements on the land. It also provides cost-share funds if 30-year easements are placed on wetlands (Johnson 1999). The Conservation Reserve Enhancement Program (CREP) is a new initiative that awards additional funds for conservation projects that address critical water quality, soil erosion, and wildlife habitat needs (USEPA 1998). Each state can submit a proposal for CREP funds to enroll up to 100,000

acres. States that have been funded have received an average of $200 million to acquire or obtain easements on riparian buffers and wetlands (Johnson 1999). The Environmental Quality Incentives Program (EQIP) provides technical assistance, incentive payments, and up to 75 percent cost-sharing for establishing conservation practices, including buffer strips. Although 50 percent of funds are reserved for livestock producers, CAFOs are specifically excluded (USDA NRCS 1997). Finally, the Wildlife Habitat Incentives Program offers funds to help improve wildlife habitat. Taken together, these programs offer hundreds of millions of dollars in assistance to preserve and restore riparian buffers on agricultural lands.

Local governments can take an active role in setting priorities and coordinating water protection efforts with farmers and representatives of the NRCS, the local Soil and Water Conservation District, and the local Resource Conservation and Development Agency. A cooperative approach will allow local governments to work toward their water quality goals while minimizing the regulatory burden on the agricultural community.

Good Communications

Riparian buffer width, extent, and vegetation should be based on science, not political expediency.

Local governments should involve landowners and developers in the process of developing riparian buffer ordinances. This will greatly reduce the possibility of legal challenges and make enforcement substantially easier. To reach landowners, clear and concise informational materials should be prepared to inform them of the requirements of the proposed ordinance, the benefits of buffers, and the fact that the ordinance respects their rights as landowners. Once the ordinance has been approved, these materials can be updated for permanent use.

The purpose of involving developers and landowners is to ensure that the ordinance respects property rights and is responsive to the needs of affected parties concerning variance procedures and administrative methods. It should not be viewed as a process for making watered-down compromises on stream buffer protection. Stream buffer width, extent, and vegetation should be based on science, not political expediency.

Determining Clear Variables

If a variable-width buffer option is used, it is necessary to develop expedient procedures for determining buffer width. The variables incorporated into the variable-width options presented here were chosen partly because they are readily measured in the field. Most commonly, buffer delineation will occur when a site is initially surveyed for development. On small parcels of land with fairly uniform topography, it may be possible to estab-

lish a uniform buffer width for the entire property. To accurately reflect the environmental conditions on larger properties, the width of the buffer should be determined at regular intervals along the stream. Slope can be determined by measuring the difference in elevation between the stream bank and a point approximately 100 feet inland, perpendicular to the stream bank. Wetlands should be identified and delineated using the criteria of the U.S. Army Corps of Engineers (1991).

How impervious surfaces are handled depends on their nature. If a road parallels the stream and lies within the buffer area, then the buffer should be increased by its average width. A decision must be made, however, on whether small areas of impervious surface will require an increase in buffer width. For example, if a small paved parking area exists within the buffer, is the buffer width to be increased just at that point? We recommend that local governments exempt impervious surfaces smaller than a predetermined area.

Additionally, there is a technical problem of how to handle impervious surfaces, wetlands, and steep slopes that lie partly within and partly outside the buffer. The normal procedure is to first determine the buffer width based on slope (and, for Option One, the width of the floodplain). Then, a check is made to determine whether any wetlands, very steep slopes, or impervious surfaces lie within this buffer. If they do, the width is increased by the width of the feature that is within the buffer. If the feature extends beyond the buffer, then the width is extended by the total width of the feature. For example, using Option Two, a stream running through a valley with a 10 percent slope would have a 70-foot buffer. A wetland lies within the outer 20 feet of the buffer and extends an additional 30 feet beyond. The buffer width is increased by all 50 feet of the wetland.

Ordinance Enforcement

A buffer ordinance is only as good as its enforcement. Enforcement costs time and money, but for many local governments the increased demands are relatively low (Herson-Jones 1995). In many cases, enforcement will be handled by an existing staff member, such as a building inspector. No matter who enforces the ordinance, he or she cannot do so without clear guidelines.

As indicated by the Heraty (1993) survey, discussed previously, it is essential to indicate accurately the boundaries of stream corridors on all site evaluation/design base maps. Such maps will generally be required as part of the development review policy.

Thorough mapping is the only way to ensure that contractors responsible for various stages of the development project are unlikely

to disturb or damage the buffer area during construction. In addition, site inspectors are able to verify that buffer regulations have been followed (Herson-Jones 1995).

Boundaries should be clearly indicated at construction sites, and temporary fencing should be used to ensure that there is no accidental intrusion in the buffer area. Site inspections should be made prior to construction to verify that buffer boundaries are accurately delineated and clearly marked. At least one subsequent inspection should be made during construction to ensure that the buffer is respected.

Minimizing the Effects of Riparian Buffer Crossings/Bypasses

Road crossings and other breaks in the riparian buffer reduce buffer width to zero and allow sediment and other contaminants to pass directly into the stream (Swift 1986). Buffer crossings may, in fact, be where the majority of sediment is transported to the stream. All buffer crossings should be avoided if possible, but when they are necessary Schueler (1995) suggests that

- crossing width should be minimized;
- direct (90 degree) crossing angles are preferable to oblique crossing angles;
- construction should be capable of surviving 100-year floods;
- free-span bridges are preferable to encasing the stream; and
- banks must be properly stabilized.

As in the attached model ordinance, local governments should exempt necessary road and utility crossings from buffer restrictions. These exemptions, however, require justification for such crossings and the use of all appropriate best management practices (BMPs). Crossings should be regularly monitored, especially after severe storms and floods, to determine if excessive sedimentation is occurring. Sewer lines that cross streams should also be inspected to ensure that they are not leaking or damaged in any way.

It is also essential to minimize practices that cause water flow to bypass the riparian zone. Drain tiles used to improve drainage from agricultural fields discharge flow directly into the stream (Fennessy and Cronk 1997, Osborne and Kovacic 1993, Vought et al. 1994). Jacobs and Gilliam (1985) compared fields drained by a riparian buffer with fields drained by ditches and drain tile. They observed high nitrate reduction in the riparian buffer, but much lower nitrate loss in drainage ditches and very little nitrate loss for fields drained by tile. Osborne and Kovacic (1993) recom-

mend constructing riparian wetlands at the outflow of the drain tile to intercept nutrients and allow them to be processed and slowly infiltrate into the stream.

Similarly, in urban areas, storm drains carry contaminant-laden water from impervious surfaces directly into streams. This practice should be avoided, if not banned. Ideally, runoff should be allowed to infiltrate into the soil as close as possible to the source. If some drainage is required, outflow should either be directed in the form of sheet flow across a suitably wide riparian buffer or into stormwater detention ponds or constructed wetlands. When necessary, constructed wetlands may be incorporated into the riparian buffer if they are properly located and do not harm existing wetlands or other critical riparian features (Schueler 1995).

Supporting Restoration

To properly perform their functions, stream corridors should be maintained in a naturally vegetated state consisting of native trees and understory plants. If the buffer does not currently support this type of forest community, restoration is necessary. Sometimes restoration can be achieved simply by leaving the site alone and allowing it to naturally revert to forest; in other cases, streambanks must be stabilized, native trees need to be planted, or other forms of management may be necessary.

In their ordinances, local governments may require developers to perform any necessary riparian restoration work as a condition for issuing site development permits. At the least, restoration should be encouraged on all sites. Many restoration projects do not require a great deal of technical expertise and can be conducted by volunteer organizations such as scout troops and Adopt-a-Stream organizations. There are numerous technical publications available that provide guidance for stream corridor restoration. (See Appendix B.)

Buffers and Private Property Rights

Perhaps the biggest impediment to establishing riparian buffer ordinances is concern for private property rights. Yet, a well-written ordinance that is administered fairly will balance protection of water quality and wildlife habitat with the rights of property owners. It is entirely possible to provide strong protection for riparian buffers while respecting the rights of property owners.

Buffers protected by a riparian buffer ordinance remain in the ownership of the property owner. This is in contrast to greenways, which are generally publicly owned. A buffer ordinance should never mandate public access to private property, nor should it restrict activities on a property to such an extent that the owner cannot make use of it. These conditions would be grounds for a takings lawsuit (discussed here). If a local government cannot provide adequate buffer protection along a stream segment without infringing on property rights, then the government must either acquire the parcels in question or try to offset the lack of protection with controls (whether regulatory or voluntary) somewhere else in the stream basin.

The Issue of Takings

Today, any discussion of land-use management must include the takings issue. Originally, the word "taking" referred to cases when the government physically appropriated private property for public works projects and was required to offer "just compensation" under the Fifth Amendment. Later, the courts determined that it is possible for laws to regulate properties to such an extent that the effect is virtually the same as a physical taking. Relatively few laws have been found to have this effect, however (Witten 1997, Zoeckler 1997).

Under the U.S. Constitution, a taking will occur

a. if the law fails to advance legitimate state interests *or*
b. deprives a property of all or nearly all viable economic use *or*
c. constitutes an invasion or mandates open access to the property.

Courts have clearly demonstrated that laws designed to protect water quality or even the environment in general are justified in the interest of public health, safety, and welfare (Witten 1997, Zoeckler 1997). In the case of *Lucas v. South Carolina Coastal Council* (1992), the U.S. Supreme Court noted that uses of property may be denied if they constitute a public nuisance, in accordance with long-established common law (Patterson 1993). Since nonpoint source pollution of water may constitute a public nuisance

and riparian buffers are effective at preventing such pollution, the buffers may be protected from takings claims on these grounds as well.

In most cases, loss of some—but not all—economic value does not constitute a taking. In other words, the courts have determined that landowners do not have an absolute right to the most economically valuable use of their land. They do, however, have the right to exclude others from their land. Any law that requires landowners to allow public access to their property runs the risk of being declared a taking. Witten (1997) notes that the courts have determined that such access exactions must be justified by the activity being permitted by the ordinance; i.e., they must be "roughly proportional" (*Dolan v. City of Tigard* [1994]).

It is possible for an ordinance to be a taking under Georgia, but not federal, law.

An ordinance can also be declared a taking under the Georgia Constitution. Georgia courts consider similar criteria as federal courts in making such a determination, but there are some significant differences. In Georgia, government regulations are presumed to be valid unless it is proven that

a. the regulation causes "significant detriment" *and*
b. there is an "insubstantial relationship" between the regulation and the public interest.

Although both these tests must be met, it is possible for an ordinance to be a taking under Georgia law but not federal law. However, Georgia courts have upheld the validity of riparian buffer protection programs. In a unanimous decision in *Threatt v. Fulton County* (1996), the Georgia Supreme Court ruled that the county's riparian buffer ordinance, based on the Metropolitan River Protection Act, did not constitute a taking: "[T]here has been no showing that the buffer area or any other applicable regulation has deprived the condemnees of any or all economically viable or beneficial use of their property… nor is this a situation in which it can be argued that fairness and justice dictate that the burden imposed by the regulation be borne by the public as a whole" (Zoeckler 1997).

It is not clear what, if any, negative effects riparian buffers have on property values as a whole. On the one hand, buffers reduce the permissible uses on portions of properties, which would tend to reduce their value. On the other hand, studies have shown that home buyers will pay a premium for land that includes or is adjacent to protected stream corridors (National Park Service 1995). This issue will be discussed further.

An ordinance established in accordance with the recommendations that we have presented should run very little risk of being declared a taking of property. However, it is wise to anticipate potential problems and

establish systems that reassure landowners that their rights will not be violated. This requires three components, discussed earlier:

1. A degree of flexibility in administering the buffer program
2. Fair, understandable, but strict procedures for variances
3. Open communication with landowners

How Much Land Is Affected by Riparian Buffers

Those concerned with property rights frequently suggest that riparian buffers will deprive small landowners of the use of most or all of their land. Buffer proponents counter that these concerns are greatly exaggerated. However, both parties frequently lack information to resolve this dispute. Several questions arise:

- How much of a land parcel of a given size is taken up by a buffer of a given width?
- Is there a property size threshold, beneath which buffers take up an inordinate percentage of the property area?
- What proportion of properties are affected by buffers in a typical developing county or municipality?
- What is the total area taken up by buffers in a typical county or municipality?

We can find simple answers to some of these questions with a few basic mathematical calculations. For example, a square one-acre lot is about 200 feet on each side. If the lot borders a stream, a 100-foot buffer will take up 50 percent of the lot. A square quarter-acre lot that borders a stream would lie entirely within the buffer. Of course, a lot that has been subdivided to a quarter-acre probably has a house on it (or will have one soon), which would earn it an exemption as a preexisting activity under the buffer ordinance proposed here. But what is the effect of buffers on larger lots that have not yet been subdivided, or on lots of unusual shape?

We conducted a study to determine the area of actual properties covered by a riparian buffer of various widths. We used a Geographic Information System (GIS) to draw buffers onto a tax parcel map. A tax map from Cherokee County was used as an example because the county lies within an environmentally sensitive region, is rapidly growing, and includes parcels of varying size. In addition, the study examined some countywide effects of riparian buffer protection.

Tax Parcel Map Analysis

The first part of the study used a tax parcel map from Cherokee County to examine the effects of a riparian buffer ordinance on individual prop-

erties. The map that was selected depicted parcels ranging in size from 1 acre to 120+ acres, including some that have been recently developed and some that are expected to be developed soon. Those about to be developed are of most interest because they are the ones most likely to be affected by the riparian buffer ordinance. Figure 3 shows the tax parcel map with buffers of 50 feet, 75 feet, and 100 feet, respectively. Although riparian buffers are indicated around all ponds, only those water bodies that cross property boundaries will be affected by the ordinance. Therefore, only the two ponds in the left center of the maps are included in calculations.

Thirty-eight percent of the parcels on the map could theoretically be affected by riparian buffers because they include or are adjacent to a stream or protected pond (again, however, recall that existing uses are "grandfathered," so most parcels would not be affected by a buffer ordinance in the near future, or possibly ever). Among affected parcels, a 50-foot buffer covers an average of 10.86 percent of the property area. A 75-foot buffer covers an average of 16.32 percent of affected properties, and a 100-foot buffer covers an average of 21.59 percent of affected properties.

Figure 3. Area of Tax Parcels Covered by Riparian Buffers of Different Widths

This figure shows 50-foot buffers. Numerals 1-7 indicate parcels that are described in the text and in Table 2.

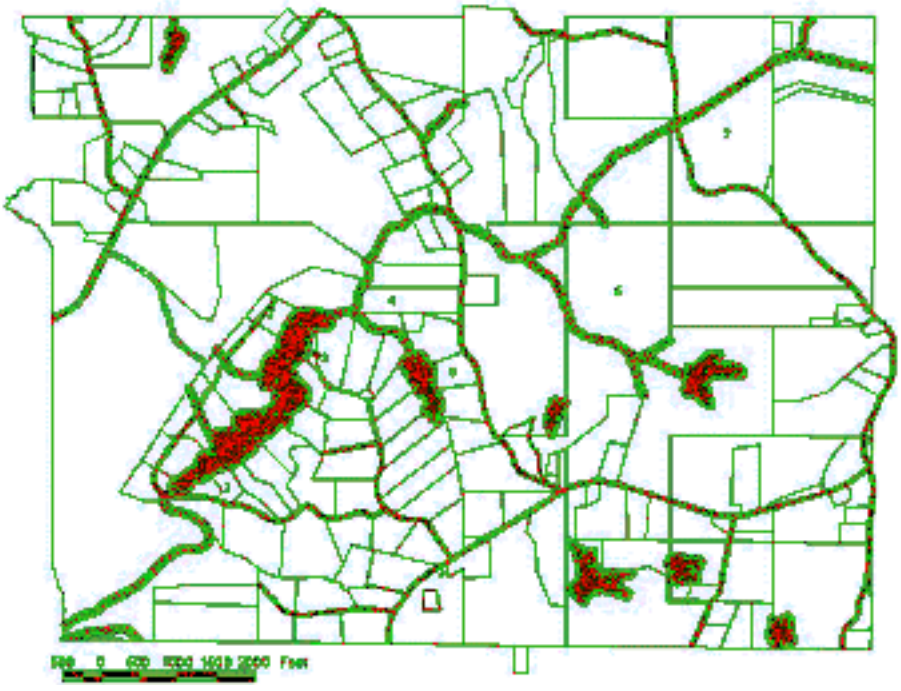


Figure 3 (*continued*). Area of Tax Parcels Covered by Riparian Buffers of Different Widths

The top figure shows 75-foot buffers, while the bottom figure shows 100-foot buffers. Numerals 1-7 indicate parcels that are described in the text and in Table 2.

Seven parcels, indicated on the maps by numerals, have been selected as examples. The characteristics of these parcels are shown in Table 1. Property 1 is slightly less than 3 acres. A 50-foot buffer covers 11.7 percent of the property, while a 100-foot buffer covers 23.16 percent. While this area is significant, there is clearly sufficient area left on the parcel (2.2 acres) for constructing a house or other structure. Property 2 is larger but loses a similar proportion of its area to the buffer because it has a longer section of shoreline (note that the areas on both sides of the road are included in this parcel). Property 3 is a smaller lot (1.2 acres) with a relatively long section of shoreline. Even a 50-foot buffer takes up almost half of the property, and a 100-foot buffer covers 85 percent of its area. If this parcel were not exempted, the owner would clearly have grounds for a variance to a 75- or 100-foot buffer. Due to the property's shape, the owner might even qualify for a variance from a 50-foot buffer.

Properties 4 and 5 are further examples of medium-sized properties that lose appreciable land area to the buffer but are clearly still quite usable. Property 6 is a 76-acre lot that is crossed by a stream and two small tributary creeks. Even with 100-foot buffers, however, the property only loses 10.70 percent of its area. Property 7 is a 120-acre lot that loses 6.12 percent of its land area when covered by 100-foot buffers.

Although it is not possible to generalize too much from these few examples, some observations can reasonably be made. For large properties of 70 acres or more, the effect of even wide buffers is likely to be minimal to developers. To a farmer, the losses could be significant, but agricultural operations are almost always existing activities and would therefore be

Table 1. Proportion of Parcels Covered by Riparian Buffers of Different Widths

ID numbers in this table indicate parcels shown on the tax maps (Figure 3).

Parcel		Percent of Property Covered by Buffer		
ID Number	Size (acres)	50 feet	75 feet	100 feet
1	2.8	11.7	17.4	23.1
2	5.0	10.5	15.6	20.8
3	1.2	47.3	68.0	85.3
4	10.4	4.2	6.4	8.5
5	4.9	8.2	12.8	16.6
6	76.4	5.2	7.9	10.7
7	120.1	3.1	4.6	6.1

exempted. Medium-sized parcels of 3 to 70 acres will be affected but not generally to the point where they are not able to be developed. Many properties in this size class have been created as large-lot subdivisions and will likely be exempted as existing activities. But if they are not, the land lost to even a 100-foot buffer will almost always be less than 25 percent, which is not sufficient to preclude reasonable use.

On the other hand, small parcels of less than 3 acres are likely to be significantly impacted by wide (100-foot) buffers, and parcels of 1 acre or less will be significantly impacted by 50-foot buffers. Lots of a quarter acre or less may be swallowed up by riparian buffers. Again, it must be noted that such lots will generally be exempted because they have already been subdivided for residential or commercial purposes.

As discussed previously, the major effect of a riparian buffer is to alter patterns of future development away from streams and rivers. This means that mostly large properties are affected, and as was shown here, the effect on large properties is not excessive. Incorporating a buffer ordinance into the subdivision site plan should not have a negative economic effect on the developer; indeed, as will be discussed, the effect can even be positive.

Countywide Analyses

To examine the effect of a buffer ordinance on the county scale, digital maps of streams, rivers, and lakes derived from USGS topographic maps were used along with a map that showed land cover for Cherokee County derived from satellite images. Results showed that if 50-foot riparian buffers were applied to every stream, river, and lake that appeared on the map, a total of 5.9 percent of the county would be covered by buffers. For 75-foot buffers, 8.6 percent would be covered and for 100-foot buffers 11.3 percent would be included within buffer boundaries. On one hand, this is an underestimate because topographic maps do not include all streams and are not recommended for defining protected streams (they were used in this study solely because they were readily available in digital form). On the other hand, however, this is a gross overestimate of the impact that buffers would have in the short term, because it does not account for any exceptions or variances.

Land cover within 100-foot (30 meters) buffers is summarized in Table 2. Deciduous forest is the most common land cover within riparian buffers in Cherokee County (56.45 percent), followed by mixed forest (25.07 percent) and evergreen forest (8.07 percent). If all forest classes and wetland classes are combined, 91.39 percent of county riparian corridors are covered in some type of natural vegetation. The remainder of the riparian zones are in pasture/hay (4.57 percent), low-intensity residential (1.45 percent), or other uses (2.59 percent).

Table 2. Frequency of Land Cover Types in Riparian Zones in Cherokee County

Land Cover Type	Percent of Riparian Zone in Land Cover Type	
	100 foot (30 meter) zone	50 meter zone
Low-Intensity Residential	1.45	1.45
Hi-Intensity Residential	0.08	0.08
Hi-Intensity Commercial/Industrial	0.63	0.59
Bare Rock/Sand	0.01	0.01
Quarries/Mines/Pits	0.04	0.04
Transitional Barren	0.81	0.91
Deciduous Forest	56.45	53.89
Evergreen Forest	8.07	9.56
Mixed Forest	25.07	25.16
Pasture/Hay	4.57	5.58
Row Crops	0.81	0.91
Other Grasses	0.21	0.26
Woody Wetlands	0.98	0.92
Herbaceous Wetlands	0.82	0.64
Total	100.00	100.00

These results indicate that the vast majority of riparian corridors have the potential to serve as effective buffers. At present, these areas are not heavily utilized for agriculture or development, and in most areas protecting 100-foot buffers would not have an effect on existing land uses. Nevertheless, we still expect that local governments will exempt existing uses to ensure that the ordinance is politically acceptable.

Conclusions

Riparian buffers can cover a very significant portion of small properties. Those that are not exempted from a buffer ordinance will require variances. However, in most cases these properties will be exempted because they constitute existing uses. The effect of riparian buffers on medium to large properties is not sufficient to cause a major negative economic effect on landowners in any but exceptional cases, and even a 75-foot to 100-foot riparian buffer ordinance should not impose an unreasonable burden on property owners. In the case of Cherokee County, more than 90 percent of the riparian zones are covered by forest or wetlands, indicating a high potential for effective riparian buffer protection.

Economic Considerations Regarding Buffers

Streams and riparian zones have economic value. This value can be broken down into a number of components, some of which are obvious and some of which are not. For example, an obvious value is that of the timber in a riparian zone that can be cut and sold. A less obvious value is that of an endangered species living in a river, which could become extinct if the riparian zone is not protected. The obvious values are what economists call "market values" because we can measure them in actual prices, while the less obvious ones are "nonmarket." They are real, but are harder to measure because they don't correspond to things that are commonly bought and sold. A riparian buffer ordinance offers economic benefits by preserving both market and nonmarket values. However, it also carries some economic costs, most of which are related to the costs of administration and the loss of unrestricted use of properties. Table 3 summarizes many of these costs and benefits.

It is important to note that most of the actual costs of having buffer ordinances relate to market values, while many of the benefits are nonmarket. If these nonmarket values are ignored, people will tend to undervalue riparian buffers, which can lead to poor protection and negative impacts on both the environment and the economy (Bollman 1984). The purpose of this section is to call attention to the economic benefits of riparian buffers so that they can be included in peoples' decisions. No attempt is made to quantify the actual economic benefits or costs of buffers, because such an assessment is beyond the scope of this project. The purpose here is to show that riparian buffers *do* have economic benefits, and these can be equal to or greater than the economic costs of a buffer ordinance.

As discussed previously, it is helpful to think of the riparian buffer as a land-use planning tool. In deciding to protect the riparian buffer, we are determining how best to use land in a riparian zone. Bollman (1984) summed up the situation:

> In making a decision as to how much, if any, of a riparian system is to be given up for the development of homesites, the administrator should take into account the relative scarcity of this resource or the relative scarcity of the wildlife and fish it supports and the amenities and recreation it makes available, and compare this with the relative scarcity of homesites in this vicinity or close by. Are there substitute opportunities for such homesites?

Table 3. Economic Costs and Benefits of a Riparian Buffer Ordinance

Costs	Benefits
Local Government	
Staff time Staff training Technical assistance to developers and landowners Public education efforts	Increased property values Bank stabilization and erosion control Low-maintenance stormwater management Reduction in flood damage Groundwater recharge Preservation of wildlife habitat Increased recreational opportunities and revenues Preservation of drinking water quality
Developers and Property Owners	
Technical surveys and reports Buffer delineation Loss of developable land Buffer restoration Buffer protection during construction	Increased property values Low maintenance stormwater management Bank stabilization and erosion control Increased diversity of wildlife Increased recreational opportunities Direct economic uses of buffer (e.g., logging)

Most of Georgia has no shortage of substitute sites for homes. Providing substitutes for the functions of the riparian buffer, however, is not easy and could require considerable expense. This expense represents the economic value of the buffer. When this value is fully considered, it becomes clear that in most cases the best land use for a riparian zone is as a functional riparian buffer.

The Costs

As shown in Table 3, a buffer ordinance imposes costs on a local government in the form of staff time, staff training, public education efforts, and technical assistance to landowners and developers. For most local govern-

ments, the greatest expense is staff time (Herson-Jones 1995). Although these costs should be relatively easy to quantify, telephone calls to local government officials revealed that most governments do not track the expenses of their buffer programs. Therefore the actual staff time dedicated to buffer program administration is not known.

For landowners, the most significant cost of the ordinance is likely to be the loss of full use of the land covered by the riparian buffer. Any negative impact that this has on property values is offset to some degree by the positive effects of improved aesthetics, discussed in the next section. Other costs include time spent delineating the riparian buffer and completing necessary documentation to submit to the local government authority. Protecting the riparian buffer during construction might also add slightly to construction costs. If the stream channel is degraded, the local government could require the landowner to take measures to stabilize the banks and restore vegetation.

The Benefits

Direct Economic Uses

A protected riparian buffer is not without economic value. For example, selective logging is acceptable within the riparian zone, provided it is not conducted immediately adjacent to the stream and appropriate best management practices (BMPs) are observed. Rob Miller, the owner of a diversified agriculture business in Oregon, installed riparian buffers for bank stabilization and water quality purposes, but found that the system could also be profitable. He was quoted as saying, "We've found that if we use trees in the riparian buffer that produce profitable wood, we can help the environment *and* make a profit…we can make this system pay for itself" (USDA Forest Service 1997). Other nondestructive uses of buffer land include hunting, hiking, and water-based recreational activities.

The Value of Recreation and Tourism

Rivers and streams are natural magnets for recreational activities. A protected riparian buffer acquired by the local government can serve as a public park or greenway, a function with significant economic value. Of course, most buffers protected by an ordinance will remain in the ownership of individuals, and it is usually not legal or desirable for a government to mandate access to these lands. Still, these buffers can contribute positively to recreation and tourism by improving water quality and by improving the aesthetics of stream corridors, both of which are important for water-based recreational activities. Determining the economic value of stream recreation gives us an indication of the value of riparian buffers.

Buffers can contribute positively to recreation and tourism by improving water quality and the aesthetics of stream corridors.

There are several ways to calculate this. Crandall et al. (1992) used three techniques to quantify the economic value of The Nature Conservancy's Hassayampa River Preserve in Arizona: the Contingent Valuation Method (CVM), the Travel Cost Method (TCM), and local economic impact analysis. CVM is a survey-based method used to quantify the nonmarket value of resources. It has become an accepted standard among federal agencies, and even though it has its share of detractors, the method has been shown to produce reliable results (Carson and Mitchell 1993, Loomis and White 1996). Using CVM, researchers asked visitors how much they would be willing to pay to ensure that there were adequate instream flows to maintain a healthy river system. Respondents were willing to pay an average of $65, or a total of $520,000. For the TCM, the river preserve was valued based on the amount of money and time visitors spent to visit it. The TCM estimated the value of the preserve at $613,360. Local economic impact analysis determined that visitors who came to the area specifically to visit the preserve contributed $88,240 to the local economy (Crandall et al. 1992).

These methods have been used to value parks in Georgia as well. Visitors to state parks spend as much as $13.26 per visit (Bergstrom et al. 1990). Recreationalists on one segment of the Broad River near Athens, Georgia, contribute $88,200 in total output to the local economy each year. Visitors further responded that if the Broad River were officially protected, their number of annual visits would nearly double, yielding another $79,772 in economic output (Bradford 1991). Whitewater rafting on the Chattooga River in North Georgia contributes some $2.29 million in total economic output to the state (English and Bowker 1996).

Property Value Increases

A protected stream or river corridor is an aesthetic amenity that can increase property values in the nearby community. Quantifying the effect of a single factor on property values requires an economic method known as the hedonic price technique. Kulshreshtha and Gillies (1993) used this method to analyze the value of the South Saskatchewan River to the residents of the city of Saskatoon, Canada. They found that houses closer to the river were worth $1,044 to $33,363 more than otherwise similar homes in the same neighborhood. Rental properties close to the river were valued at $34 per month more. Based on this research, the authors calculated the total aesthetic value of the river at $1.2 million.

For a developer, a riparian buffer ordinance has the effect of requiring subdivision projects to take the form of conservation subdivisions. That is, the property is subdivided in such a way that individual lots are clustered together and a significant area of land is preserved in a natural

state. Studies have shown that home buyers will pay more to live in a well-designed conservation subdivision (National Park Service 1995). In addition, clustering homes allows the developer to save money on infrastructure costs, which itself can offset the costs of development. Georgia developer Steve MacCaulay, who specializes in conservation subdivisions, says that he can make the same profits off of conservation subdivisions as he can from conventional designs (1999). In "The Economics of Watershed Protection," Schueler (1997) concludes that buffers and certain other watershed protection tools "all maintain the equity value of a parcel since they increase the value of developed properties."

Whether or not the increase in property value is large enough to cancel out the negative effect buffers can have on regulated properties depends on factors such as the size of the parcel and the nature of the land use. Cases will vary widely, but the following patterns appear likely:

- Small- to medium-sized parcels directly affected by the buffer may experience a slight decrease in property value. Landowners who would suffer significant economic hardship would qualify for a variance under the proposed buffer ordinance.
- For large properties that are subdivided for housing development, the effect is likely to be neutral.
- Properties near a protected riparian buffer but not directly affected by the buffer may experience a slight increase in property value.

The net effect across a county is likely to be neutral, yielding no net increase or decrease in property tax revenue for a local government (Schueler 1997).

The Value of Clean Water

Perhaps the most important purpose of riparian buffers, as far as local governments are concerned, is to maintain good water quality. Of course, it is very difficult to determine the precise contribution of buffers to clean water without extensive (and expensive) monitoring. Nevertheless there are methods available to determine the value of the water quality services of a buffer as well as to determine the value of clean water itself.

The most straightforward way to measure a buffer's water quality services is to determine how much it would cost to provide similar services using technological approaches. The Congaree Bottomland Hardwood Swamp in South Carolina is estimated to provide ecosystem services equivalent to a $5 million water treatment plant (Floodplain Management Association 1994). A study in Maryland determined that using riparian buffers and nonstructural controls was more cost-effective than engineered solutions in reducing nutrient pollution by 40 percent. The nonstructural approach

was estimated to cost some $2.2 million, while equivalent structural techniques would cost $3.7 million to $4.3 million per year (Palone and Todd 1998). The city of Boulder, Colorado, decided that the services provided by Boulder Creek and its riparian zone were more valuable than those provided by a new nitrification tower, and chose to restore the stream system rather than to construct the technological solution (National Park Service 1995). Riparian buffers can also eliminate the need for engineered stormwater management systems, which can cost from $500 to $10,000 per acre (Palone and Todd 1998).

One way to value buffer functions is to determine how much people are willing to pay for clean water.

The value of buffers can also be determined by the costs saved in the treatment of drinking water. For many contaminants, including sediment, there is a direct relationship between quantity of pollutant and cost of treatment. The city of Roswell, Georgia, has seen its water treatment costs increase by 50 percent over the course of three years, due mainly to increased turbidity in the water (Moring 1999). Preventing sedimentation (and other forms of contamination) by establishing buffers upstream of water intakes and reservoirs may be more cost-effective than paying to remove the pollutants once they have entered the water. This was the approach that New York City used in acquiring lands in its watershed rather than constructing a new treatment facility. Water treatment is not only the business of municipalities, but of industry as well. To fully value clean water, one should also consider the amount spent by water-dependent manufacturers (such as breweries) to treat water for their production processes.

A riparian buffer ordinance is a planning tool: it prevents stream degradation before it happens. Therefore, a buffer's value can further be estimated from the amount of money people are willing to pay for stream restoration once damage has occurred. Montgomery County, Maryland, is spending $20,000 to $50,000 *per housing lot* in some areas to restore degraded streams and riparian zones. In an equally extreme case, Fairfax County, Virginia, is spending $1.5 million to restore two miles of degraded stream and riparian area (Palone and Todd 1998).

Another approach to valuing buffer functions is to determine how much people are willing to pay for clean water, using the Contingent Valuation Method. Carson and Mitchell (1993) determined that people are willing to pay an average of $275 per household per year (in 1990 dollars) to achieve the goals of the Clean Water Act. Based on this, total benefits provided by clean water in the United States (not counting the benefits of drinking water) were approximately $46.7 billion in 1990. This exceeds the Department of Commerce's estimates of the costs of the Clean Water Act for 1988 ($37.3 billion) but is lower than the projected costs of the Clean Water Act in 2000 and beyond.

A 1986 CVM study found that Chicago residents would pay $30–$50 to improve the quality of the city's streams and rivers (Croke et al. 1986). The authors suggested that this relatively low value was due to the fact that residents relied mostly on Lake Michigan for recreational purposes, so there was less demand for stream services. Lant and Tobin (1989) used CVM to determine the value of services provided by riparian wetlands in Iowa river basins. In the Edwards basin, the value of wetland services was found to be roughly equivalent to the value of the land as cropland. In the Skunk River Basin, the riparian zones were found to be worth 10 times as much as functioning wetlands than as farmland. The Skunk River riparian zones were highly valued because wetlands were relatively scarce and their services were valued by the population of the nearby metropolitan area of Ames, Iowa. Because such services have not been measured by market value, however, riparian zones are often misallocated to farming purposes. This represents a net economic loss to all citizens.

Fox et al. (1995) calculated the economic benefit of improved water quality from agricultural soil conservation practices, based on water treatment costs and the value of sport fishing. The researchers determined that narrow buffer strips on agricultural land in a 8,155 acre watershed will produce a water quality benefit of more than $36,000. The cost of sacrificing agricultural income from the land used for these narrow buffer strips was $481. Of course, such buffer strips are not the same as wide riparian buffers, but even if the land lost from production were 20 times as great as the authors suggested, the cost would still be under $10,000—less than a third of the benefits.

The Value of Endangered Species

Studies have shown that people will pay to preserve habitats for various endangered species.

Threatened and endangered species have value to people even when they provide no direct economic benefits. Economists have used CVM to determine how much people are willing to pay to ensure that these organisms survive. This represents the existence value of species (how much people value the continued existence of these organisms), as well as the bequest value (the value of leaving some of these organisms for future generations) and option value (the value of having an option to do something with species in the future, even if we have no direct economic uses for them at present). Studies have shown that people will pay $3–$9 per year to preserve habitat for relatively obscure nongame species such as the Colorado Squawfish (*Ptychocheilus lucius*) and the Striped Shiner (*Notropis chrysocephalus*). They will pay considerably more ($30–$60 per year) for higher profile species such as the Chinook Salmon (*Oncorhynchus tshwytscha*) (Loomis and White 1996). One study found that Washington households would pay $73 per year to re-

move dams and restore the Elwha River to improve salmon populations (Loomis 1998). Studies such as this can serve as a guide in determining the economic benefits of habitat protection tools such as riparian buffers. For example, if each of the almost 100,000 residents of Cherokee County were willing to pay just $5 per year to protect threatened and endangered fish species, the estimated value of the county's aquatic habitat would be $500,000. At least a few studies of this sort should be conducted in Georgia to determine the economic value of nongame wildlife, currently valued very little.

Regional Quality of Life Benefits

Protecting riparian buffers can have other long-term positive impacts on the economy of a region. Clean water, like clean air, can be a significant economic asset. A community that protects its natural resources through the use of buffer ordinances and other laws may find that it is easier to attract both businesses and employees. Respondents to a 1995 survey by *Money* magazine ranked clean air and water as the two most important factors in choosing a place to live—even above low crime rates and low taxes (US EPA 1996). On the state level, it has been shown that the states with the highest levels of environmental protection also have the best economies (Fodor 1999). An aesthetically pleasing environment can improve the efficiency level of the workforce and reduce turnover (Kulshreshtha and Gillies 1993). Therefore, a local government that protects its natural environment also protects its economic future.

Conclusions

This section has shown that there are concrete economic benefits of riparian buffers and that economic tools exist to quantify these benefits. However, there is still the need for a detailed study on the economic costs and benefits of a specific riparian buffer ordinance. Such a study should include such elements as

- a determination of the costs of actual administration and enforcement of a buffer ordinance,
- a study of the hedonic effects of a buffer ordinance on property values, and
- a contingent valuation study of people's willingness to pay for protected and improved water quality.

A thorough economic analysis of this sort would provide information to resolve some of the debate that surrounds buffers and to help local governments create buffer programs that provide the greatest economic and environmental benefits.

Even without such a study, it is apparent that the economic benefits of buffers are at least of a magnitude comparable to their costs. In the future, we can expect the economic balance to tilt even more in favor of protecting riparian zones and other natural resources. Technological advances are steadily reducing the costs of agricultural and industrial goods, but the same cannot be said of natural features such as riparian zones. Therefore, in terms of goods and services produced from the agricultural and industrial sectors, the natural environment is becoming increasingly valuable (Bollman 1984). It makes economic sense to preserve these areas and locate extractive or destructive uses elsewhere when possible (Bollman 1984).

Summary of Recommendations

Over the course of this paper, we have endeavored to supply the reader with sufficient information to create an effective, legally and politically defensible program for protecting riparian buffers. However, we recognize that by including this amount of information—and a number of relevant digressions—we run the risk that the major points might be lost. To ensure that does not happen, we summarize here the key steps to developing an effective riparian buffer ordinance.

- Pass a riparian buffer ordinance that protects all perennial and intermittent streams based on the model included in this publication. The buffer ordinance should emphasize the multiple formations of riparian buffers and should specify that buffers be maintained in a naturally forested state.
- Develop a public information campaign to explain the benefits of a riparian buffer ordinance, the restrictions of the buffer ordinance, and procedures for seeking variances.
- Identify critical riparian areas in which existing land uses may pose a threat to water quality. Such areas include cattle watering spots, areas where chicken waste is applied to fields, older homes with septic drain fields, etc. Develop a program to work with landowners and other government entities (e.g., Natural Resources Conservation Services) to minimize stream impacts in these areas.
- Identify high-priority wildlife habitat areas, historic or prehistoric sites, and other exceptional areas in the county that merit preservation. All floodplain lands that are not included in a protected stream corridor should automatically be included in this list. Some riparian corridors of 300-foot width or greater should also be included. These high-priority areas should be designated "sending areas" under a transferable development rights (TDR) program, if present. Funding should be pursued to acquire high-priority areas that otherwise cannot be preserved.
- Establish limits on impervious surfaces to control runoff.
- Properly enforce erosion and sedimentation control statutes.
- Amend the jurisdiction's existing flood damage prevention ordinance to include language that emphasizes the importance of limiting floodplain development for purposes of flood storage, water quality protection, and wildlife habitat preservation. Prohibit activities in the floodplain that could directly threaten water quality, including application of fertilizers and pesticides, siting of animal waste lagoons, and disposal of hazardous materials, including motor oil.

- Establish a 25 NTU turbidity standard to monitor erosion and sedimentation control and riparian buffer effectiveness in different stream segments.

References

Arnold, C. L., Jr., and C. J. Gibbons. 1996. Impervious surface coverage: The emergence of a key environmental indicator. *APA Journal* 62 (2): 243-58.

Barling, R. D., and I. D. Moore. 1994. Role of buffer strips in management of waterway pollution: A review. *Environmental Management* 18 (4): 543-58.

Beasley, B. 1998. Personal communication with author, 14 September.

Bergstrom, J. C., H. K. Cordell, A. E. Watson, and G. A. Ashley. 1990. Economic impacts of state parks on the economies of the South. *Southern Journal of Agricultural Economics* (December): 6977.

Billingsley, T., and B. Mizerak. 1997. *Sustaining Georgia's aquatic resources: A partnership on the Etowah*. Athens: Georgia Environmental Policy Institute, University of Georgia.

Binford, M. W., and M. J. Buchenau. 1993. Riparian greenways and water resources. In Smith, D. S., and P. Cawood, eds. *Ecology of Greenways*. Minneapolis, Minn.: University of Minnesota Press.

Bledsoe, M., J. Covert, W. Jones, A. Rivers, and K. Tyler. 1998. *An introduction to transferable development rights*. Athens: University of Georgia.

Bollman, F. H. 1984. Economic analysis and the management of riparian resources. Pages 221-25 in R. E. Warner and K. M. Hendrix, eds., *California riparian systems: Ecology, conservation and management*. Berkeley: University of California.

Bradford, B. D. 1991. An economic analysis of river corridor protection. Master's thesis, University of Georgia.

Brock J. 1998. Personal communication with author, 18 November.

Brown County Board of Supervisors. 1998. *An ordinance to create chapter 10 of the Brown County code relating to agricultural shoreland management*. Brown County, Wis.

Brown, W. E., and D. S. Caraco. 1997. Muddy water in—muddy water out? *Watershed Protection Techniques* 2 (3): 393-403.

Carson, R. T., and R. C. Mitchell. 1993. The value of clean water: The public's willingness to pay for boatable, fishable, and swimmable quality water. *Water Resources Research* 29 (7): 2445-54.

Cowie, G., and P. Hardy. 1997. *Environmental management requirements for stream and river corridors in Georgia.* Athens: University of Georgia.

Crandall, K. B., B. G. Colby, and K. A. Rait. 1992. Valuing riparian areas: A southwestern case study. *Rivers* 3 (2): 88-98.

Croke, K., R. Fabian, and G. Brenniman. 1986. Estimating the value of improved water quality in an urban river system. *Journal of Environmental Systems* 16 (1): 13-24.

Dean, C. 1997. A case study of the establishment and revision of watershed regulations for Douglas County, Georgia. Pages 220-21 in K. J. Hatcher, ed., *Proceedings of the 1997 Georgia Water Resources Council*. Athens: University of Georgia.

Desbonnet, A., P. Pogue, V. Lee, and N. Wolf. 1994. *Vegetated buffers in the coastal zone: A summary review and bibliography.* Providence: University of Rhode Island.

English, D. B. K., and J. M. Bowker. 1996. Economic impacts of guided whitewater rafting: A study of five rivers. *Water Resources Bulletin* 32 (6): 1319-28.

Federal Interagency Floodplain Management Task Force (FIFMTF). 1996. *Protecting floodplain resources: A guidebook for communities*. Federal Emergency Management Agency (Washington, D.C.: FEMA 268, June).

Fennessy, M. S., and J. K. Cronk. 1997. The effectiveness and restoration potential of riparian ecotones for the management of nonpoint source pollution, particularly nitrate. *Critical Reviews in Environmental Science and Technology* 27 (4): 285-317.

Ferguson, B. 1998. Personal communication with author, 20 November.

Floodplain Management Association. 1994. Economic benefits of wetlands. *FMA News: The Newsletter of the Floodplain Management Association* (July).

Fodor, E. 1999. Better not bigger: How to take control of urban growth and improve your community. Gabriola Island, Canada: New Society Publishers.

Fowler, L., and H. Neuhauser. 1998. A Landowner's Guide: Conservation Easements for Natural Resource Protection (2d ed.). Athens, Ga.: Georgia Environmental Policy Institute/Georgia Department of Natural Resources.

Fox, G., G. Umali, and T. Dickinson. 1995. An economic analysis of targeting soil conservation measures with respect to off-site water quality. *Canadian Journal of Agricultural Economics* 43: 105-18.

Fulton County Board of Commissioners. 1998. *South Fulton County tributary protection ordinance*. Fulton County, Ga.

Georgia Department of Natural Resources, Environmental Protection Division (GA DNR EPD). 1998. *Public notice 98-17 (Georgia's unified watershed assessment process)*. Atlanta: GA DNR EPD.

Georgia Forestry Commission. 1995. *Georgia's best management practices for forestry*. Macon, Ga.: Georgia Forestry Commission.

Georgia Forestry Commission. 1999. *Georgia's best management practices for forestry*. Macon, Ga.: Georgia Forestry Commission.

Georgia Soil and Water Conservation Commission (GSWCC). 1994. *Guidelines for stream bank restoration*. Atlanta: GSWCC.

Herson-Jones, L. M. 1995. *Riparian buffer strategies for urban watersheds*. Washington, D.C.: Metropolitan Washington Council of Governments.

Jacobs, T. C., and J. W. Gilliam. 1985. Riparian losses of nitrate from agricultural drainage waters. *Journal of Environmental Quality* 14 (4): 472-78.

Johnson, A. P. 1999. Buffering Georgia with creativity and federal programs. Pages 223-26 in K. J. Hatcher, ed., *Proceedings of the 1999 Georgia Water Resources Conference*. Athens: University of Georgia.

Klein, R. D. 1979. Urbanization and stream quality impairment. *Water Resources Bulletin* 15 (4): 948-63.

Kulshreshtha, S. N., and J. A. Gillies. 1993. Economic evaluation of aesthetic amenities. *Water Resources Bulletin* 29 (2): 257-66.

Kundell, J. E., and T. C. Rasmussen. 1995. *Erosion and sedimentation: Scientific and regulatory issues*. Athens: University of Georgia.

Lant, C. L., and G. A. Tobin. 1989. The economic value of riparian corridors in cornbelt floodplains: A research framework. *Professional Geographer* 41 (3): 337-49.

Loomis, J. B. 1998. Estimating the public's values for instream flow: Economic techniques and dollar values. *Journal of the American Water Resources Association* 34 (5): 1007-14.

Loomis, J. B., and D. S. White. 1996. Economic values of increasingly rare and endangered fish. *Fisheries* 21 (11): 6-10.

MacCaulay, S. 1999. Personal communication with author, 31 March.

Malanson, G. P. 1993. *Riparian landscapes.* Cambridge, U.K.: Cambridge University Press.

Maryland Office of Planning. 1993. *Preparing a sensitive areas element for the comprehensive plan.* Baltimore, Md.: Maryland Office of Planning.

May, C. W., R. R. Horner, J. R. Karr, B. W. May, and E. B. Welch. 1997. Effects of urbanization on small streams in the Puget Sound Lowland Ecoregion. *Watershed Protection Techniques* 2 (4): 483-94.

Miller, A. E., and A. Sutherland. 1999. *Reducing the impacts of storm water runoff through alternative development practices.* Athens: University of Georgia.

Moring, S. 1999. Personal communication with author, 30 March.

National Park Service. 1995. *The economic impacts of protecting rivers, trails and greenway corridors: A resource book.* San Francisco: National Park Service Western Regional Office.

Osborne, L. L., and D. A. Kovacic. 1993. Riparian vegetated buffer strips in water-quality restoration and stream management. *Freshwater Biology* 29: 243-58.

Palone, R. S., and A. H. Todd (eds.). 1998. *Chesapeake Bay riparian handbook: A guide for establishing and maintaining riparian forest buffers.* Radnor, Pa.: USDA Forest Service. NA-TP-0297.

Patterson, J. J. 1993. California land use regulation post Lucas: The history and evolution of nuisance and public property laws portend little impact in California. *UCLA Journal of Environmental Law & Policy* 11: 175-201.

Peterson, S. C., and K. D. Kimball. 1995. *A citizen's guide to conserving riparian forests.* Portland, Ore.: River Network.

Rublee, P. 1999. Personal communication with author, 26 January.

Schueler, T. 1995. *Site planning for urban stream protection.* Silver Spring, Md.: Center for Watershed Protection.

————— . 1997. The Economics of Watershed Protection. *Watershed Protection Techniques* 2 (4): 469-81.

Swift, L. W., Jr. 1986. Filter strip width for forest roads in the Southern Appalachians. *Southern Journal of Applied Forestry* 10: 27-34.

Trimble, S. W. 1997. Contribution of stream channel erosion to sediment yield from an urbanizing watershed. *Science* 278: 1442-44.

Tyler, K., S. Hitch, and H. Sample. 1998. *Case studies: River protection on a regional (watershed) basis.* Athens: University of Georgia.

U.S. Army Corps of Engineers (USACE). 1991. *Buffer strips for riparian zone management.* Waltham, Mass.: USACE.

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). 1997. *EQIP Q&A's.* Washington, D.C.: USDA.

United States Department of Agriculture (USDA). 1998. *Stream corridor restoration: Principles, practices and processes.* Draft internet release. [http://www.hqnet.usda.gov/stream_restoration/]. Accessed October 1, 1998.

United States Department of Agriculture Forest Service. 1997. Essential buffers provide economic benefits. *Inside Forestry* (Fall), USDA Forest Service, Rocky Mountain Research Station.

United States Environmental Protection Agency (USEPA) 1996. *Liquid assets.* Washington, D.C.: US EPA.

University of Georgia School of Environmental Design (UGASED). 1997. *Land development provisions to protect Georgia water quality.* Atlanta: Georgia Department of Natural Resources.

————— . 1998. *Clean water action plan: Restoring and protecting America's waters.* Washington, D.C.: USEPA. EPA-840-R-98-001.

Vead, M. 1998. Personal communication with author, 24 September.

Verhovek, S. H. 1999. Salmon put on U.S. list as at risk. *New York Times on the Web.* [http://www.nytimes.com]. Accessed March 25, 1999.

Vought, L. B.-M., J. Dahl, C. L. Pedersen, and J. O. Lacoursière. 1994. Nutrient retention in riparian ecotones. *Ambio* 23 (6): 343-48.

Wahl, M. H., H. M. McKellar, and T. M. Williams. 1997. Patterns of nutrient loading in forested and urbanized coastal streams. *Journal of Experimental Marine Biology and Ecology* 213: 111-31.

Wenger, S. J. 1999. *A review of the scientific literature on riparian buffer width, extent and vegetation.* Athens: Institute of Ecology Office for Public Service and Outreach, University of Georgia.

West, D. 1998. Personal communication with author, 3 December.

Witten, J. 1997. *Counties and the takings issue: How far can government go in regulating private property?* Washington, D.C.: National Association of Counties.

Zoeckler, R. L. 1997. *A summary of takings law.* Athens: Georgia Environmental Policy Institute.

Appendix A: Model Riparian Buffer Ordinance

This is a sample riparian buffer ordinance, using a fixed width, written as an amendment to an existing zoning ordinance. It creates a new buffer overlay zone along all perennial and intermittent streams. Local governments that have not adopted a zoning ordinance may use a stand-alone version, available from the University of Georgia Institute of Ecology Office of Public Service and Outreach. A variable-width buffer ordinance is also available. Call 706-542-3948 or email *lfowler@arches.uga.edu* for further information.

This ordinance complies with the state minimum standards for river corridor protection as well as the minimum standards for water supply watershed protection that relate to riparian buffers. Some local governments may be subject to additional requirements for water supply watershed protection. These requirements are summarized at the end of this document.

Language that is optional or variable is indicated by brackets and/or parentheses. The name of the local government should be inserted for [*county/municipality*].

ARTICLE [X] RIPARIAN BUFFER ZONE

1. INTENT AND PURPOSE.

This section establishes the justification for the ordinance. It should be tailored to emphasize the important aquatic resources of the local area.

The streams and rivers of [*county/municipality*] supply much of the water required by [*county/municipality*] citizens for drinking and other municipal and industrial uses [*alternatively, for regions that rely on groundwater*]. The quality of the groundwater that is used for drinking, agricultural and industrial purposes in [*county/municipality*] is connected with the quality of the surface water in the streams and rivers of [*county/municipality*]. Furthermore, the people of [*county/municipality*] use the surface waters for fishing, canoeing, and other recreational and economic purposes. The [*county/municipality*] Board of Commissioners finds that the protection of the streams and rivers of [*county/municipality*] is vital to the health, safety and economic welfare of its citizens.

For example, if endangered species of fish are present, insert a sentence that says "In addition, the [local river] and its tributaries provide habitat for a number of threatened and endangered species of fish." If these terms are defined previously in the zoning ordinance then they may not have to be redefined here.

It is therefore the intent of this ordinance to amend the Zoning Ordinances of [*county/municipality*] to establish a new riparian buffer zone of restricted development and limited land use adjacent to all perennial streams and rivers in [*county/municipality*]. The purposes of the riparian buffer zone are: to protect public and private water supplies, to trap sediment and other pollutants in surface runoff, to promote bank stabilization, to protect riparian

wetlands, to minimize the impact of floods, to prevent decreases in base flow, to protect wildlife habitat, and to generally maintain water quality.

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 water quality shall apply.

2. TITLE.

This Ordinance shall be known as "The Riparian Buffer Zone Requirements of [*county/municipality*]" and may be referred to generally as "Riparian Buffer Requirements."

3. DEFINITIONS.

"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.

"Impervious surface" means any paved, hardened or structural surface which does not allow for complete on-site infiltration of precipitation. Such surfaces include but are not limited to buildings, driveways, streets, parking lots, swimming pools, dams, tennis courts, and any other structures that meet the above definitions.

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

The width of the riparian buffer zone is first defined here. Naturally, this width must be consistent throughout the ordinance. We recommend a width of 100 feet, which is consistent with state minimum standards. If

"Protected area" means any land and vegetation that lies within the riparian buffer zone, as defined herein.

"Riparian Buffer Zone" or "RBZ" is an overlay zone that encompasses all land within 100 feet [*or other fixed width, but never less than 50 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.

"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 a United States Department of Agriculture Soil Survey Map of the most recent edition; and

(b) 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

(c) any lake or impoundment that does not lie entirely within a single parcel of land; and

(d) any other stream as may be identified by [*county/municipality*].

a width narrower than 100 feet is specified, a separate ordinance or section of this ordinance must be added to cover those stream segments governed by minimum standards (water supply watersheds and large rivers). "Stream bank" means the uppermost limit of the active stream channel, usually marked by a break in slope.

This ordinance specifies the use of soil survey maps, which may be the most accurate maps for determining affected streams. In some areas other map types may be preferable. This section should be changed to refer to the most accurate map available for the jurisdiction, with accuracy determined by field evaluations.

4. DISTRICT USE AND REGULATIONS.

4.1. The Riparian Buffer Zone District (RBZ) is an overlay zone that encompasses all land within 100 feet [*or width defined above*] on either side of all streams in [*name of county/municipality*], measured as a line extending from the stream bank. The RBZ must be maintained in a naturally vegetated state. Any property or portion thereof that lies within the RBZ is subject to the restrictions of the RBZ 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 protected area:

(a) any land-disturbing activity;
(b) septic tanks and septic tank drain fields;
(c) buildings, accessory structures, and all types of impervious surfaces;
(d) hazardous or sanitary waste landfills;
(e) receiving areas for toxic or hazardous waste or other contaminants;
(f) mining;
(g) storm water retention and detention facilities, except those built as constructed wetlands that meet the approval of the Office of Planning and Zoning of [*county/municipality*].

5. EXCEPTIONS.

5.1. The following land uses are excepted from the provisions of Section 4:

(a) 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

Local governments with port facilities may wish to except these facilities provided they meet certain requirements.

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.

(b) Agricultural 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.

(c) Selective logging, except within 50 feet [*or other distance, but never less than 25 feet*] of a stream and provided that logging practices comply with the best management practices set forth by the Georgia Forestry Commission.

(d) Crossings by transportation facilities and utility lines. However, issuance of permits for such uses or activities is contingent upon the completion of a feasibility study that identifies alternative routing strategies that do not violate the RBZ, as well as a mitigation plan to minimize impacts on the RBZ.

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

(f) Structures which, by their nature, cannot be located anywhere except within the riparian buffer zone. These include docks, boat launches, public water supply intake structures, facilities for natural water quality treatment and purification, and public wastewater treatment plant sewer lines and outfalls.

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

Important Note:

Section 5.1(h)-1 exceeds the state minimum standards by requiring the residence to be located outside of the riparian buffer if possible. As of this writing, such a provision may require EPD approval. Contact the University of Georgia, Institute of Ecology Office of Public Service and Outreach, for more information on this issue.

(h) 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 Riparian Buffer Zone; 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 be only one such dwelling on each two-acre or larger tract of land; and

5. septic tank drain fields shall not be located within the buffer area, although a septic tank or tanks serving such a dwelling may be located within the RBZ.

(i) Other uses permitted by the Georgia DNR 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. All excepted uses shall be located as far from the stream bank as reasonably possible.

6. MINOR VARIANCES.

Minor variances allow for "buffer averaging," which gives the landowner a fast and easy method for reducing the width of the RBZ by small amounts, if necessary.

6.1. A minor variance is a reduction in buffer width over a portion of a property in exchange for an increase in buffer width elsewhere on the same property such that the average buffer width remains 100 feet [*or width specified above*]. No minor variance can decrease buffer width to less than 75 feet [*or 25 feet less than the buffer width*]. A property owner may request a minor variance from the requirements of the RBZ by preparing the appropriate application with the [*county/municipality*] Office of Planning and Zoning.

6.2. Each applicant for a minor variance must submit documentation that issuance of the variance will not result in a reduction in water quality. All minor variances shall adhere to the following criteria:

(a) the width of the RBZ shall be reduced by the minimum amount possible, and never to less than 75 feet [*or 25 feet less than the buffer width*] at any point; and

(b) reductions in the width of the RBZ shall be balanced by corresponding increases in the RBZ elsewhere on the same property, such that the total area included in the RBZ is the same as if it were 100 feet [*or width specified above*] wide; and

(c) land-disturbing activities must comply with the requirements of the Erosion and Sedimentation Act of 1975 and all applicable best management practices.

7. MAJOR VARIANCES.

7.1. A major variance is a reduction in RBZ width that is not balanced by a corresponding increase in buffer width elsewhere on the same property, or else a reduction in buffer width to less than 75 feet [*or as specified*

above]. A property owner may request a major variance from the requirements of the RBZ by preparing the appropriate application with the [*county/municipality*] Office of Planning and Zoning. Such requests shall be granted or denied by application of the criteria set forth below in section 24.7.3 and will be subject to the conditions set forth below in section 24.7.4. Under no circumstances may an exception be granted which would reduce the buffer to a width less than the minimum standards established by state or federal law.

7.2. Each applicant for a major variance must provide documentation that describes:

(a) existing site conditions, including the status of the protected area; and

(b) the needs and purpose for the proposed project; and

(c) justification for seeking the variance, including how buffer 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.

Section 7.3a is designed to ensure that any landowner who might have grounds for a claim of "takings" can qualify for a variance. Section 7.3b is designed to ensure that even those landowners with lots smaller than two acres, as of the effective date of the ordinance, can construct a single-family dwelling within the buffer if necessary to prevent extreme hardship. Landowners with lots of two acres or larger who must encroach on the buffer in order to construct a home are excepted in section 5.1(h)-1.

7.3. No major variance shall be issued unless the [*county/municipality*] Zoning Board of Appeals determines that:

(a) the requirements of the RBZ represent an extreme hardship for the landowner such that little or no reasonable economic use of the land is available without reducing the width of the RBZ; or

(b) the size, shape, or topography of 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 Riparian Buffer Zone.

7.4. Any major variance issued by the [*county/municipality*] Zoning Board of Appeals will meet the following conditions:

(a) the width of the RBZ is reduced only by the minimum extent necessary to provide relief; and

(b) land-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 federal 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 land-disturbing activities to ensure that water quality is not impaired.

8. REPEAL CLAUSE.

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.

ADDITIONAL WATER SUPPLY WATERSHED REQUIREMENTS.

The above ordinance meets the riparian buffer provisions of the state minimum standards for water supply watershed protection. However, the minimum standards place other restrictions on small and large water supply watersheds in addition to riparian buffer requirements. A water supply watershed is the drainage basin upstream of governmentally owned drinking water supply intake; a small water supply watershed is less than 100 square miles, while a large water supply watershed is 100 square miles or larger. A water supply reservoir is a governmentally owned impoundment of water for the primary purpose of providing water to one or more governmentally owned public drinking water systems.

Within a seven-mile radius upstream of a water supply reservoir, no impervious surfaces, septic tanks or septic tank drain fields may be installed within 150 feet of a stream bank. *Note: The EPD can approve alternate criteria for protecting drinking water standards. Because the ordinance above is generally stricter than the state minimum standards, the EPD may allow local governments to waive certain criteria, such as the 150-foot impervious surface/septic setbacks. We do not recommend waiving the other requirements described here.*

In both large and small water supply watersheds, new facilities which handle hazardous materials of the types and amounts determined by the Department of Natural Resources must perform their operations on impermeable surfaces having spill and leak collection systems as prescribed by the Department of Natural Resources.

In small water supply watersheds only, new hazardous waste treatment or disposal facilities are prohibited, and new sanitary landfills are allowed only if they have synthetic liners and leachate collection systems. The impervious surface area (including all public and private structures, utilities or facilities) of the entire water supply watershed shall be limited to twenty-five percent (25%) of the area of the watershed or existing use, whichever is greater.

Appendix B: Additional Riparian Buffer Resources

For more information, see the following resources, categorized by topic. Publications data for this additional material can be found in the References.

Riparian Buffers

Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers.
R. S. Palone and A. H. Todd, eds., 1998.
Available on the Internet at *http://www.chesapeakebay.net/facts/forests/handbook.htm*.

Site Planning for Urban Stream Protection.
T. Schueler, 1995.
Available from the Center for Watershed Protection at 410-461-8323.

State and Federal Laws Affecting Streams and Rivers

Environmental Management Requirements for Stream and River Corridors in Georgia.
G. Cowie and P. Hardy, 1997.
Available from the EPD at 1-888-EPD-5947 (Atlanta: 404-657-5947).

Floodplain Protection

Protecting Floodplain Resources: A Guidebook for Communities.
Federal Interagency Floodplain Management Task Force, 1996.
Available from the EPD floodplain management office at 404-656-6382.

Conservation Easements

A Landowner's Guide: Conservation Easements for Natural Resource Protection (second edition).
L. Fowler and H. Neuhauser, 1998.
Available from the Georgia Environmental Policy Institute at 706-546-7507.

Reducing Impervious Surfaces and Other Local Environmental Provisions

Land Development Provisions to Protect Georgia Water Quality.
University of Georgia School of Environmental Design, 1997.
Available from the EPD at 1-888-EPD-5947 (Atlanta: 404-657-5947).

Reducing the Impacts of Storm Water Runoff through Alternative Development Practices

A. E. Miller and A. Sutherland, 1999

Available from the Institute of Ecology, University of Georgia, Athens, GA 30602-2202; call 706-542-2968; or email *lfowler@arches.uga.edu.*

Stream Restoration

Stream Corridor Restoration: Principles, Practices and Processes

USDA interagency document, 1998.

Available on the Internet at *http://www/hqnet.usda.gov/streams_restoration.htm.*

Guidelines for Stream Bank Restoration

Georgia Soil and Water Conservation Commission, 1994.

Available from GSWCC at 706-542-4242.

Takings

Counties and the Takings Issue: How Far Can Government Go in Regulating Private Property?

J. Witten, 1997.

Available from the Association County Commissioners of Georgia at 404-522-5022.

A Summary of Takings Law

R. L. Zoeckler, 1997.

Available from the Georgia Environmental Policy Institute at 706-546-7507.

Transferable Development Rights (TDRs)

An Introduction to Transferable Development Rights

M. Bledsoe et al.

Available from the Institute of Ecology at 706-542-2968.

For Other Model Ordinances for Natural Resources Protection, Contact:

Office of Public Service and Outreach

Write to Institute of Ecology, University of Georgia, Athens, GA 30602-2202; call 706-542-2968; or email *lfowler@arches.uga.edu.*