Riparian Buffers (RB)

Aerial photo of streamside forest, courtesy of Greg Jennings

Site Selection

Quantity Control	---
Drainage Area	small-med
Space Required	med-large
Works with:	
Steep Slopes	---
Shallow Water Table	✔
Poorly Drained Soils	✔

General Significance

Construction Cost	med
Maintenance	low
Community Acceptance	high
Habitat	med-high
Sun / Shade	sun to p. shade

Synonyms: Filter strips, streamside vegetation, streamside forest, aquatic buffers, corridors, greenways, riparian zones, engineered buffers, buffer strip, water pollution hazard set backs, vegetated buffers, biological buffer zones

Riparian buffers are permanently vegetated transition zones that connect upland areas to streams. Prior to development, most streams in the Southeast had naturally occurring riparian buffers. These streamside forests slow runoff velocity, create diffuse flow, and reduce nonpoint source (NPS) pollution concentrations before runoff enters nearby streams or other water bodies. Buffers filter pollutants from agricultural, urban, suburban, and other land cover through natural processes such as deposition, infiltration, adsorption, filtration, biodegradation, and plant uptake. Riparian buffers also stabilize streambanks and provide food and shelter to wildlife to connect otherwise fragmented wildlife communities in a watershed. Riparian buffers are often recommended as part of a holistic watershed management plan aimed at reducing NPS pollution.

Site Selection

Riparian buffers are sited adjacent to surface waters such as perennial, intermittent, and ephemeral streams. To be considered a LID practice, a riparian buffer should be restored and enhanced. Restored riparian buffers work well in high density, urban areas, such as residential subdivisions and can be used in conjunction with other stormwater control measures (SCMs) that help reduce flashy urban flows.

Permanent Easements: A long term or permanent easement is recommended to protect the restored buffer from development, clearing, or unnecessary extensive plant maintenance that might limit buffer functionality.

Right of Way: The restored riparian buffer should not be in a current right of way (ROW) for sewer, power, or other infrastructure.

Buffer Width: Buffer width may be a function of surrounding land use, land availability, or topography and may vary throughout the watershed. Check local ordinances on buffer width as these regulations can vary across the state from 25’ to 150’. Narrower buffers can be just as effective as wider buffers in removing sediment in environments where rainfall events are consistently light; however, buffers in regions that experience heavy or frequent rain events in urbanized settings may require wider buffers to adequately reduce sediment and other pollutants.

Slope: Slope can greatly affect buffer width and a slope of < 6% is recommended to slow runoff through riparian buffers. Steeper slopes may require larger buffer widths due to increased runoff velocities that decrease residence

Table 4.8.1
Site Selection: Constraints and Limitations for Riparian Buffers

Constraint	Recommendations
Width	Effectiveness is minimized in buffers < 25' wide
Slope	Preferred < 6%, may need to be wider if > 6%
Flow	Flow should not be concentrated. Use a level spreader to disperse concentrated flow entering the buffer. Flow entering the buffer should also not exceed 3 cubic feet per second (cfs).
Sediment	Does not work with high sediment inputs
Right of Way (ROW)/ established buffer	Only replaces impaired buffers, must have an access easement

time in the buffer and reduce infiltration or filtration. It is generally noted that increased buffer width can help to reduce sediment loads.

Flow: Flows into the buffer should not exceed 3cfs.

Design

The design of restored riparian buffers includes site selection, determining the dimension of the buffer, and proper vegetation selection and placement. Improvements to riparian buffers may include replanting native vegetation to reduce erosion and eradicating nonnative, invasive plants.

Components

Pretreatment: A grassed filter strip for pretreatment is encouraged, but not required for restored riparian buffer functionality. Grassed filter strips can aid in nutrient and sediment load reductions by reducing runoff velocities and dissipating energy. Grassed filter strips are planted with turfgrass for ease of maintenance and to create diffuse flow into the buffer to allow sediment to settle out of suspension.

Practice Pairing: Often restored riparian buffers are paired with other structural SCMs, such as level spreaders to aid in creating diffuse flow into the riparian buffer. See Chapter 4.5 on Level Spreaders and Grassed Filter Strips for more information.

Dimension: A restored riparian buffer typically has two zones with an optional third zone. A minimum of 100' buffer width is recommended for stream protection; however, some areas of Alabama recommend smaller widths.

Zone 1: Zone 1 is closest to the water body and is designed to create, preserve, and protect physical and ecological functions. This floodplain zone is crucial to the physical and ecological integrity of the stream ecosystem and often has wetland characteristics and critical habitats. Zone 1 should have restricted human use and is planted with native vegetation that protects streambank stability. This zone may range from 25 – 30' wide perpendicular to the stream or water body and is primarily made up of a mix of wetland herbaceous, and woody vegetation.

Zone 2: Zone 2 is the transition area between the upland and Zone 1. Zone 2 is the primary treatment area for pollutant removal. This zone is designed to infiltrate runoff and promote filtration of pollutants. The width of this zone ranges from 20 - 50' perpendicular to the stream additonal to Zone 1, depending on stream and floodplain characteristics. Woody vegetation is the primary vegetation in this zone. Intrusions into this zone should be minimized.

Zone 3: An optional transition to a 25' wide filter strip of grassed or herbaceous plant species is recommended to create diffuse flow into Zone 2. Zone 3 is typically planted with native grasses.

Construction

Construction of a restored riparian buffer should consider stream channel stabilization, vegetation, soil preparation, floodplain or buffer stabilization, and planting.

Permits: Proper permits must be obtained if stream channel stabilization is needed.

Stream Channel Stabilization: Stream channel stabilization combines vegetative and structural techniques. Two recommended vegetation techniques to stabilize streambanks are the use of live stakes and brush mattresses. Structural measures or in-stream features, such as rock vanes, log vanes, or sills, may be necessary to improve streambank stability. Hard armoring streambanks using riprap or gabion baskets is not as desirable compared to more

natural, biological engineering techniques, but can be used in situations where applicable. A biological or agricultural engineer should be consulted when stream channel stabilization is necessary.

Invasive Plant Removal: The amount of site preparation is dependent on the amount of existing native vegetation and the need for invasive, nonnative plant removal. A vegetation assessment inventory should be conducted prior to construction to identify both native and nonnative invasive plants on site. Vegetation treatment and soil preparation may require the use of herbicides or mechanical elimination of invasive, nonnative plants (see Appendix D on Vegetation for more information on invasive plant removal).

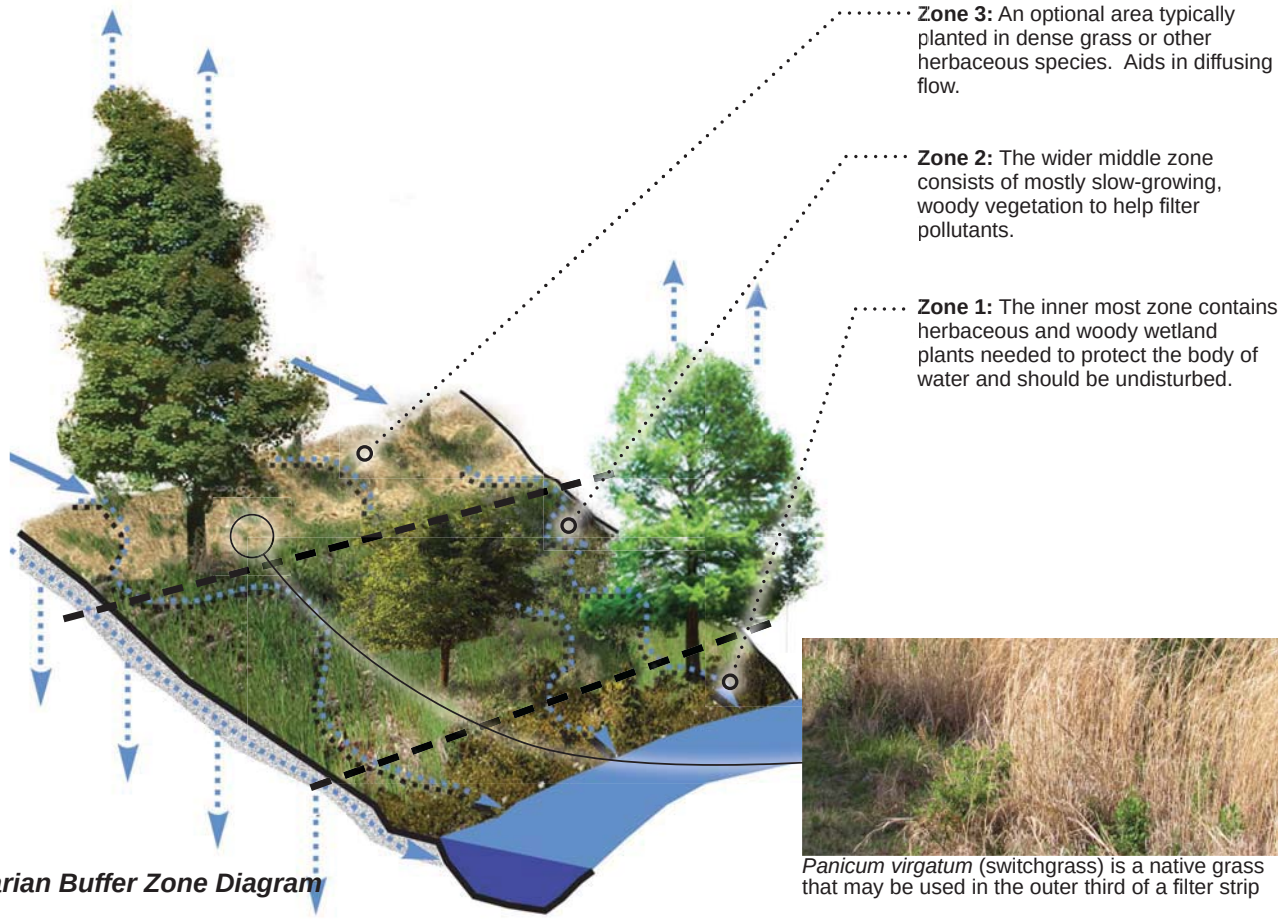
Plant Establishment: Any compacted soil should be chiseled or ripped before adding topsoil necessary for plant establishment and plant growth. Soil amendments such as lime and fertilizer should be added based on soil test results.

A 2" layer of organic mulch such as a hardwood mulch or pine straw may be used to aid in plant establishment.

Erosion and Sediment Control: Areas of bare soil must be stabilized immediately using native grasses, permanent seeding, and erosion control blankets (if necessary) following any soil disturbance according to the *Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas* **(http://swcc.alabama.gov/pages/erosion_handbook.aspx)**. Vegetation species used in stabilization should not compete with proposed native planting within the buffer.

Vegetation

Habitat Value: Vegetation has the vital role of stabilizing soil and providing habitat to wildlife in streamside forests. It is recommended to plant riparian buffers with a variety of woody and herbaceous vegetation to maximize wildlife benefit, species richness, and nutrient uptake efficiency. Leaves and twigs provide woody debris, or detritus, to the stream and are a food source to aquatic insects. Bird communities in diverse, planted or restored riparian buffers have been reported to be similar to established natural buffers. Vegetation that provides wildlife with a viable food source should be selected for the buffer. See Appendix D for the Alabama Native Plant List.



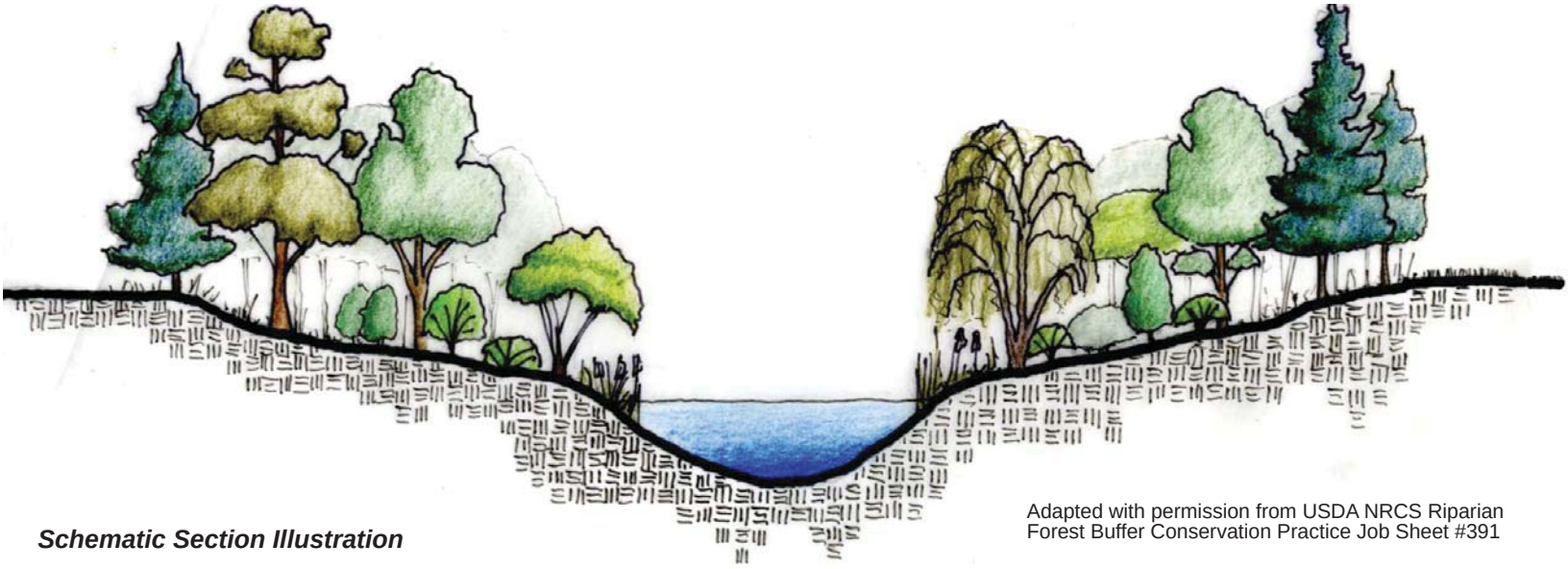
Riparian Buffer Zone Diagram

Panicum virgatum (switchgrass) is a native grass that may be used in the outer third of a filter strip

Table 4.8.2
Recommended Live Stake Species

Botanical Name	Common Name
Cephalanthus occidentalis	buttonbush
Cornus amomum	silky dogwood
Itea virginica	sweetspire
Salix sericea	silky willow
Sambucus canadensis	elderberry
Physocarpus opulifolius	ninebark

Live Stakes: Live stakes are woody stakes (0.5" diameter) harvested and installed during the winter months. Live stakes should produce roots and shoots following one growing season. Live stakes are recommended for streambank stabilization and are planted at the toe of the slope where they intercept stream base flow.



Schematic Section Illustration

Adapted with permission from USDA NRCS Riparian Forest Buffer Conservation Practice Job Sheet #391

Ida Bella Young; Montgomery, AL

Table 4.8.3
Zone 1 Plants

Botanical Name	Common Name	Type
Acer saccharinum	silver maple	tree
Alnus serrulata	hazel alder	shrub
Asimina triloba	paw paw	shrub
Aronia arbutifolia	red chokeberry	shrub
Arundinaria gigantea	river cane	grass like
Asclepias incarnata	swamp milkweed	herb
Betula nigra	river birch	tree
Carex sp.	sedge	herb
Cephalanthus occidentalis	buttonbush	shrub
Chamaecrista fasciculata	patridgepea	herb
Chasmanthium latifolium	inland sea oats	grass
*Clethra alnifolia**	summersweet	shrub
Fagus grandifolia	beech	tree
Euonymus americanus	hearts-a-burstin	shrub
Fraxinus pennsylvanica	green ash	tree
*Helianthus angustifolius**	swamp sunflower	herb
Hibiscus moscheutos	rosemallow	herb
Ilex glabra	inkberry	shrub
Ilex verticillata	winter berry	tree
Illicium floridanum	Florida anise	shrub
*Itea virginica**	sweetspire	shrub
Juncus sp.	rush	herb
Lindera benzoin	spicebush	shrub
Liquidambar styraciflua	sweetgum	tree
Liriodendron tulipifera	tulip poplar	tree
Lobelia cardinalis	cardinal flower	herb
Nyssa aquatica	swamp tupelo	tree
*Panicum virgatum**	switchgrass	grass
Platanus occidentalis	sycamore	tree
Prunus serotina	black cherry	shrub
Taxodium distichum	bald cypress	tree
Viburnum dentatum	arrowood	shrub
*Viburnum nudum**	possumhaw	shrub
Viburnum obovatum	Walter’s viburnum	shrub

*Can be used in Zone 1 or Zone 2
Zone 1: Plants in this zone experience floodplain conditions and it is planted with trees, shrubs, and perennials that tolerate periodic inundation.

Table 4.8.4
Zone 2 Plants

Botanical Name	Common Name	Type
Aesculus pavia	red buckeye	shrub
Asclepias tuberosa	butterfly weed	herb
Asimina parviflora	dwarf paw paw	shrub
Callicarpa americana	beautyberry	shrub
Calycanthus floridus	sweetshrub	shrub
Cercis canadensis	redbud	shrub
Coreopsis lanceolata	tickseed	herb
Hamamelis vernalis	witchhzael	shrub
Hamamelis virginiana	witchhazel	shrub
Lindera benzoin	spicebush	shrub
Magnolia virginiana	sweetbay	tree
*Schizachrium scoparium**	little bluestem	native grass
*Sorghastrum nutans**	indian grass	native grass
*Panicum virgatum**	switchgrass	native grass

* Can be used in optional Zone 3.

Zone 2: Zone 2 is generally considered an upland area that rarely is flooded. Plants best suited for this zone are shrubs and perennials.

Herbaceous Plants: Herbaceous vegetation is best planted in the spring, after the last frost.

Native Grasses: Tall, stiff, fine-textured native grasses such as switchgrass (*Panicum virgatum*) have deep roots compared to turfgrass and work well to stabilize riparian buffers and provide diffuse flow.

Dormant Plantings: Woody vegetation including live stakes, bare roots, and containers will benefit from a winter installation. See Appendix D on Vegetation for more information.

Summer Plantings: If summer plantings are a necessity, plants should be monitored closely for signs of drought stress and irrigated if necessary.

Plant Establishment: Newly planted vegetation will need time to adjust to the shock of being transplanted. It is recommended that transplants be watered twice a week for the first six weeks after planting, especially in the growing season.

For more information on installing live stakes, please visit: http://www.aces.edu/extcomm/timelyinfo/Ag%20Soil/2012/March/2012Live_Stakes.pdf

Tagging Plants: During planting, it may be helpful to tag or flag plants so they are easier to locate for maintenance purposes or vegetation survival monitoring.

Maintenance

Primary maintenance tasks of riparian buffers are associated with vegetation and erosion. Maintenance should be carried out such that minimal impact occurs to the buffer itself, particularly Zone 1 closest to the stream.

Nuisance Species: Wildlife may hinder plant establishment as they browse and this damage should be inspected for and corrected when possible.

Plant Replacement: Plants should be replaced when mortality occurs. Dead plants provide favorable environments for insects and diseases to overwinter and should be removed. However, it is natural that over time, plant succession will occur and plant communities in the buffer may shift.

Livestock Access: When buffers are adjacent to agriculture, fences should be maintained and repaired as needed to control livestock access to the stream.

Erosion: Gullies resulting from concentrated flow should be filled and any resulting streambank erosion should be repaired.

Mulch: Natural leaf litter should not be removed from the buffer as this provides necessary organic matter to the soil. After establishment, plants will provide leaf litter and twigs for a natural organic mulch layer in the buffer.

Thinning Trees: Trees can be thinned in the buffer, but trees with > 2" trunk diameter should not be removed. Proper tree density or cover should be present before trees or undergrowth are thinned.

Table 4.8.5
Common Invasive Nonnatives for Riparian Buffers in Alabama

Botanical Name	Common Name	Type
Ailanthus altissima	tree-of-heaven	tree
Albizia julibrissin	mimosa	tree
Hedera helix	English ivy	vine
Imperata cylindrica	cogon grass	grass
Ligustrum sinense	Chinese privet	shrub/small tree
Lonicera japonica	Japanese honeysuckle	vine
Lygodium japonicum	Japanese climbing fern	vine
Pueria montana var. lobata	kudzu	vine
Rosa multiflora	multiflora rose	shrub
Triadica sebifera	Chinese tallow	tree

Invasive Plant Removal: Invasive, nonnatives should be scouted for and removed from the riparian buffer, especially during plant establishment. As buffers colonize with native shrubs, trees, and herbaceous plants, nonnative, invasive plant removal frequency may decrease; however, annual to semi-annual surveys for nonnative, invasive plants are critical for management of these undesirable plants. See Appendix D on Vegetation for more information on invasive plant management.

Table 4.8.6
Maintenance Schedule

Task	How Often	Comments
Irrigation	After planting and during severe drought	Twice per week for 6 weeks after planting
Replace dead vegetation	Annually	Diseased or infested vegetation should be removed
Check for streambank erosion or incision	Annually	May need to replant vegetation or look upstream for causes of erosion
Inspection	After 0.5" or greater rainfall event	Visually inspect all zones of the buffer for erosion or damage.
Mowing of turf grass	More often in summer months	Should not be cut below 3 to 5" and can be grown to a maximum of 12"
Check for invasive nonnative plants	Annually	See Appendix D on Vegetation for invasive plant management guidance

Pollutant Removal

Table 4.8.7
Pollutant Removal Table

Sediment	Nutrients		Metals	Pathogens
	N	P		
a. 60%	30%	35%	-----	Med
b. 85%	30%	40%	~50%	~70%

Sources:
a. North Carolina Department of Environment and Natural Resources, 2007
b. City of Auburn, 2011

Although restored riparian buffers alone cannot provide complete surface runoff treatment (quality and quantity), buffers can filter various pollutants, particularly nutrients and sediment. Streamside vegetation transforms nutrients such as nitrogen and phosphorus into less harmful forms through nutrient cycling, plant uptake, and microbial processes.

Reduced Runoff: Restored riparian buffers provide passive volume control as stormwater is slowed by vegetation and allowed to infiltrate to groundwater.

Buffer Width: Wider buffers are generally noted to be more effective in removing pollutants, such as nutrients and sediment from surface runoff, although removal effectiveness is dependent on soil type, texture, hydrology, and biogeochemistry of underlying soils.

Total Suspended Solids: Suspended solids and turbidity are reduced through soil stabilization and erosion prevention, which can improve water quality of receiving streams. Dense grass cover in Zone 3 has been shown to be effective in filtering sediment due to increased roughness.

Nitrate Removal: Increased nitrogen reduction in wider riparian buffers is due to greater root surface area and increased nitrogen uptake through plant roots and microbial processes. Soils with subsurface anaerobic (without oxygen) conditions promote denitrification, which results in greater nitrate removal, but may result in decreased infiltration. Grass-only buffers are less effective at reducing nitrogen than forested buffers.

Vegetation: Vegetated riparian buffers shade streams, reducing water temperatures that, in turn, increase dissolved oxygen concentrations and improve water quality.

Plant Roots: Plant variety offers diversity in root morphology, which can be beneficial in soil stabilization. Riparian buffers stabilized with deeply rooted vegetation help retain soil during large rain events by reducing erosion and sedimentation. Tap-rooted plants and other deeply rooted species uptake nutrients from deeper soil horizons, stabilizing these deeper soil layers, while fibrous rooted species influence surface soil horizons. Woody plant species should be used for stabilization as these species are generally more deeply rooted compared to herbaceous plants. Native grasses are an exception to the rule. For example, switchgrass (*Panicum virgatum*) has been shown to have roots as deep as 10.8' at maturity.

Evergreen Vegetation: The presence of evergreen vegetation is desirable for nutrient removal because these plants retain their leaves and do not return nutrients to the soil during the autumn months. Fast growing plant species are suggested for areas where nutrient removal is the primary goal.

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