



Riparian Buffer Systems for Oklahoma

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Introduction

Riparian areas are the lands directly adjacent to waterbodies like streams, lakes, and wetlands. Healthy riparian areas have vegetation that reflects the transition from aquatic to terrestrial ecosystems. With careful management, riparian areas can protect water quality, promote wildlife, and maintain a healthy biodiversity without sacrificing farm productivity.

This fact sheet presents a three-zone riparian buffer system (RBS) designed to protect water quality from pesticides, nutrients, and sediment in runoff from adjacent agricultural crop lands.

Why install an RBS?

Destruction of natural riparian vegetation by agricultural and urban expansion has greatly reduced the extent of effective riparian areas in Oklahoma and across the nation. The result has been the loss of protection and consequent degradation of our water resources.

The purpose of the RBS is to protect and enhance water quality and aquatic ecosystem health. Riparian buffers accomplish this by intercepting runoff and shallow ground water on its path from uplands to receiving waters. The buffer removes nutrients, sediment, organic matter, pesticides, and other pollutants before they enter surface water or ground water recharge areas. Removal results from deposition, absorption, adsorption, plant uptake, and denitrification.

Riparian buffers also reduce flood velocities, help stabilize streambanks and lake shores, and provide important wildlife habitat. Forested riparian buffers improve aquatic habitat by shading streams, while producing trees that can be harvested for an economic return.¹ Grassed riparian buffers may also provide an economic benefit as productive livestock pasture.

¹ If the RBS is installed through a federal conservation program, harvesting trees or forage may be prohibited during the life of the conservation agreement.



A riparian buffer system protects water quality.

Not a cure-all...

To be effective, the RBS must be used in conjunction with sound upland management. It cannot compensate for poor nutrient management or erosion in upland areas. Rather, the RBS complements nutrient management and sediment control practices.

Although the RBS aids in bank stabilization, it often cannot reverse serious bank erosion problems or compensate for problems in other parts of the watershed. In channels with severely eroding banks, stream restoration and storm water and sediment control measures may be needed in addition to the RBS.

A flexible system...

The RBS is a flexible system consisting of one to three zones. Each zone has recommended minimum widths, as shown in **Table 1**. The recommended widths may be increased for different management objectives and site characteristics. Vegetation recommendations, too, are flexible, as existing stands of grass or trees often may fulfill the function of Zone 1 and Zone 2 without any modification.

Although zones differ in management, the transition from one zone to another may not be obvious. For example, Zone 1 and Zone 2 might contain similar vegetation, differing only in their management.

Conditions where practice applies: Riparian buffer systems are designed to separate water bodies from active cropland or pastures. Water bodies include perennial

or intermittent streams, rivers, lakes, ponds, and wetlands. (Note: The equivalent BMP for forestlands is the streamside management zone, or SMZ. See Forestry Extension Report #5 and OSU Extension Facts NREM-5034.)

Consider the RBS where:

- water quality is impaired and adjacent land use contributes to its degradation,
- wildlife habitat enhancement is desired,
- a water body needs protection from a threat of watershed development,
- stream temperature reduction and aquatic habitat improvement is desired, or
- streambank erosion is a concern.

In unstable streams such as those that are deeply entrenched, stream restoration measures may also be needed.

Design of the RBS

The optimal RBS has three management zones: an undisturbed zone directly adjacent to the water body (Zone 1); a managed zone to capture sediment, nutrients, and other potential pollutants (Zone 2); and a transition zone that disperses concentrated flow and captures excess sediment (Zone 3).

The RBS must have enough width to remove pollutants effectively. The recommended minimum width for a complete three-zone system is 95 feet (Zone 1, 15 ft.; Zone 2, 60 ft.; Zone 3, 20 ft.). Measure distances horizontally on a line perpendicular to the stream or shoreline, beginning at the top of the bank.

The minimum width of the RBS can be adjusted for differences in the hydrologic soil group (HSG), soil type, and slope. Consult the USDA Natural Resource Conservation Service (NRCS) for further information on this method of RBS design.

Although three zones are recommended, in some applications, two or even one zone may be sufficient. For example, Zone 2 may be omitted where there is a grassed filter strip directly above Zone 1. Zone 1, however, is always recom-

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mended for protection of water quality, aquatic habitat, and bank stability.

Zone 1 helps maintain a stable ecosystem at the water's edge and provides soil/water contact to facilitate nutrient buffering processes. This area also provides shade to

reduce water temperature and improve aquatic habitat. The slow release of nutrients from this area normally feeds the plants and animals that live in the stream. If trees are present, they may also provide large, woody debris for fish habitat.

Zone 2, is designed for active management, harvesting timber, removal of hay, and wildlife values. Grazing requires care. (Note: Grazing or agricultural production may not be allowed under some federal conservation agreements.)

Zone 3 is designed specifically for runoff control, removal of sediment, and dispersal of flow. It may include a basin for removal of sediment and special grading and shaping with diversions and level-lip spreaders to disperse flow (NRCS Standards and Specifications). Additional width may be desired to accommodate land shaping and mowing equipment. Ungrazed grasslands may meet Zone 3 requirements without modification.

Vegetation

Zone 1. Preferred are types of vegetation that will stabilize the riparian system. If trees have historically dominated the riparian vegetation of the area, they should be planted in Zone 1. In riparian areas of western Oklahoma that have not historically been capable of supporting trees, plant a mixture of native grasses, forbs, and shrubs.

Native species are preferred for Zone 1 unless a faster growing species is required to stabilize eroding banks. Include native species in the mixture to allow the native species to replace the shorter-lived, nonnative species later in succession. Consult **Table 2** for tree and shrub planting recommendations for wildlife. Avoid planting trees at the top of a high bank.

Table 1. Characteristics of the three-zone riparian buffer system (RBS).

Width	Purpose	Vegetation	Management Considerations
Zone 1 15 ft. minimum width from top of bank, measured perpendicular to stream.	1) Creates a stable ecosystem adjacent to water's edge, 2) reduces runoff nutrient levels, 3) provides shade, 4) contributes organic matter and large woody debris.	Native riparian trees, shrubs, forbs, and grasses suited to a wet environment. Use fast-growing tree species where banks must be stabilized.	Exclude heavy equipment. Remove trees only for hazard reduction. Livestock presence is discouraged except at designated stream crossings. Avoid concentrated surface runoff through use of flow spreaders.
Zone 2 60 ft. minimum width.	Provides contact time and carbon and energy sources to stabilize and store nutrients.	Predominantly native riparian trees, shrubs, forbs, and grasses.	Avoid gullying by maintaining vegetation and grading. Management for timber or wildlife is encouraged, but leaf litter and shade levels should be maintained.
Zone 3 20 ft. minimum width. Ungrazed grassland may serve as Zone 3.	1) Provides area to convert concentrated overland flow to uniform sheet flow. 2) Promotes deposition of sediment, infiltration of runoff, and uptake of nutrients by vegetation.	Dense perennial grasses and forbs.	Vegetation should be maintained in vigorous growth. Weed control may be needed. Periodic reshaping may be necessary to prevent gully formation.

For guidance in tree planting, establishment, and maintenance, consult Riparian Management Handbook (E-952) or the NRCS State Standard and Specifications for Tree Planting for Streambank and Shoreline Protection. For biodiversity considerations, refer to Oklahoma's Biodiversity Plan: A Shared Vision for Conserving Our Natural Heritage, available from the Oklahoma Department of Wildlife Conservation.

Zone 2. Predominant vegetation in Zone 2 should also consist of species selected for their ability to stabilize the riparian area. If the riparian system has been dominated by tree species historically, then trees should be planted in Zone 2. Deciduous tree species are important as sources of leaf litter and carbon. Evergreens, however, take up nutrients in winter months, protecting water quality throughout the year. Native species are preferred. Check with the Oklahoma Department of Agriculture - Forestry Division, NRCS, or U.S. Fish and Wildlife Service for species recommendations if timber, wildlife, or other benefits are desired.

In riparian areas that have not supported tree species, a mixture of shrubs, grasses, and forbs is recommended for Zone 2 (see Riparian Management Handbook, E-952).

Zone 3. To maximize nutrient uptake, dense perennial grasses and forbs are recommended. Vegetation should be maintained in a vigorous growth condition, unless this conflicts with wildlife management objectives. Select species adapted to site conditions considering other benefits, such as forage production and wildlife habitat improvement. (Refer to the NRCS Filter Strip Standard for seeding mixtures.)

Management of the RBS

Zone 1. Manage Zone 1 for sustainability of the vegetation and protection of the banks. Remove trees only if necessary for bank stabilization or if they present an unusual hazard or dangerous obstruction, such as a blocked culvert. Keep vehicles and heavy equipment out of Zone 1 except at designated stream crossings. Disturbance in Zone 1 can destabilize the entire buffer system and not allow it to function properly.

Zone 2. Active management is encouraged for Zone 2 (unless prohibited by a Conservation Agreement). Harvesting trees and other vegetation can remove nutrients, but extreme care is necessary to avoid causing erosion and loss of buffer function.

Wildlife, aesthetics, and timber production generally are compatible objectives for management of Zone 2. However, if timber is harvested in this zone, care is needed to avoid disturbing the leaf litter and large woody debris, as these are important to the primary function of the buffer. Avoid mechanical site preparation techniques that expose bare soil, such as rostraking and windrowing, piling, disking, or bedding.

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Management for wildlife habitat and aesthetics are generally compatible with riparian stabilization objectives. If other management objectives are desired, specialized plant species adapted to site conditions may be needed. Consult the Oklahoma Department of Agriculture - Forestry Division, NRCS, Oklahoma Biological Survey at the University of Oklahoma, or the U.S. Fish and Wildlife Service for species recommendations.

Zone 3. Mow and remove clippings to recycle nutrients, promote vigorous sod growth, and control weeds. This zone should be inspected frequently as it may require periodic reshaping of earthen structures, removal of accumulated sediment, and reestablishment of vegetation.

Livestock Management

Zone 1. Livestock should be excluded from Zone 1 except at designated stream crossings and watering facilities. Since this area is generally shaded and accessible to water, it may be particularly attractive to livestock. If occasional livestock access is necessary, graze only in the season when vegetation is least vulnerable and limit livestock access to short periods when soils are firm.

Zone 2. On areas planted with grass, removal of vegetative growth may be accomplished by grazing, burning, or hay harvesting. Grazing should be carefully controlled and reserved for the period when soils are dry and firm.

Zone 3. Controlled, intensive grazing, burning, and hay harvesting are all recommended (unless prohibited by a

Table 2. Tree and shrub species with relatively high value to wildlife for planting in Zones 1 and 2 of the riparian buffer system (RBS). Not all species listed are adapted for statewide planting.

Species	Zone 1	Zone 2	Species	Zone 1	Zone 2
Sugarberry (<i>Celtis laevigata</i>)	■		Red maple (<i>Acer rubrum</i>)	■	
Water oak (<i>Quercus nigra</i>)	■		Black walnut (<i>Juglans nigra</i>)		■
Shumard oak (<i>Q. shumardii</i>)		■	Red mulberry (<i>Morus rubra</i>)		■
Pecan (<i>Carya illinoensis</i>)	■	■	Sassafras (<i>Sassafras albidum</i>)		■
Green ash (<i>Fraxinus pennsylvanica</i>)	■	■	Green hawthorn (<i>Crataegus viridis</i>)		■
Black gum (<i>Nyssa sylvatica</i>)	■	■	American plum (<i>Prunus americana</i>)		■
Bur oak (<i>Q. macrocarpa</i>)	■	■	Black cherry (<i>P. serotina</i>)		■
Black oak (<i>Q. velutina</i>)		■	Deciduous holly (<i>Ilex decidua</i>)		■
Chinkapin oak (<i>Q. muehlenbergii</i>)		■	Western soapberry (<i>Sapindus drummondii</i>)		■
Black willow (<i>Salix nigra</i>)	■		Roughleaf dogwood (<i>Cornus drummondii</i>)		■
Hackberry (<i>Celtis occidentalis</i>)		■	Chittamwood (<i>Bumelia lanuginosa</i>)		■
Slippery or red elm (<i>Ulmus rubra</i>)	■		Rusty blackhaw (<i>Viburnum rufidulum</i>)		■
American or white elm (<i>U. americanus</i>)		■			

Conservation Agreement). Water, minerals, and feeding facilities should be located outside the buffer.

Flow Dispersal

Disperse upslope runoff to gully in Zone 1. Concentrated flow would effectively short-circuit the buffer. Open ditches and sub-surface drains should not cross Zone 1 or Zone 2.

Maintenance

Inspect the RBS for evidence of gully in at least annually and following severe storms. Take prompt corrective action to stop erosion and restore sheet flow.

Avoid excessive use of fertilizers, pesticides, and other chemicals in the RBS. Fertilizer use should be based on soil test recommendations to maintain vigorous plant growth. Avoid unnecessary vehicular traffic or disturbance of vegetation and leaf litter.

As forested buffers mature, Zones 1 and 2 will contribute large woody debris (LWD) to the water body. LWD provides fish habitat and traps and holds organic material for processing by aquatic organisms, thus adding energy to the stream ecosystem. This strengthens the food chain and improves aquatic habitat. However, where fallen trees obstruct flow and cause flooding or accelerated bank erosion, their removal may be necessary.

When removing trees from streams, stable portions should be retained. Debris that is removed should be placed above the high water zone.

Management for wildlife habitat and aesthetics are generally compatible with riparian stabilization objectives.

Summary

A riparian buffer system can be installed to protect water quality from intense upland land use such as rowcrop agriculture. Recommended is a three-zone system in which Zone 1, at the top of the bank, is planted with native species, suited for the expected level of moisture or flooding. This zone should be disturbed as little as possible by heavy equipment or livestock. Zone 2 is a management zone in which nutrient and sediment are stabilized, and Zone 3 is a transition to upland areas, where flow can be dispersed before it enters Zones 1 and 2. The RBS can have significant economic and aesthetic value in terms of timber production and wildlife.

References

- Oklahoma Cooperative Extension Service. Best Management Practices for Forest Road Construction and Harvesting in Oklahoma. OSU Forestry Extension Report #5.
- Anderson and Masters. Riparian Forest Buffers. OSU Extension Fact Sheet NREM-5034.
- Oklahoma Cooperative Extension Service. Riparian Management Handbook, E-952.
- Natural Resources Conservation Service. Level-lip Spreader. State Standards and Specifications.
- Natural Resources Conservation Service. State Standards and Specifications for Tree Planting for Streambank and Shoreline Protection.
- Oklahoma Department of Wildlife Conservation. Oklahoma's Biodiversity Plan: A Shared Vision for Conserving Our Natural Heritage.

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