5.2.3 Protect and Preserve Riparian Corridors

Description

A riparian corridor (sometimes called a "riparian buffer" or "riparian zone") is the land along the margins of rivers, streams, creeks, or other natural or manmade watercourses that marks the transition between aquatic and upland terrestrial habitats. These corridors vary in width, configuration, species composition, and condition, depending on the size of the watercourse and the breadth of the floodplain, as well as a number of other factors. Corridors cutting through parcels may vary in size and shape. Onsite reconnaissance is crucial to determine the appropriate land to preserve or restore. City standards and requirements take these factors into account. The applicant should review applicable rules and ascertain site-specific requirements at the concept plan review stage. Please refer to the discussion below on corridor sizing.

Figure 5.2.3-1. Highly disturbed stream with an intermittent riparian buffer.

In many cases, riparian buffers have been fragmented, drastically reduced, or removed altogether. Many streams in the Tennessee Valley suffer from disturbance caused by stormwater runoff exacerbated by development within the watershed. Bank cutting, erosion gullies, sediment muddying the water, and tree toppling along the banks are symptoms of an unstable watercourse seeking to readjust its width and depth to accommodate the increased amount and speed of water flow. Healthy riparian corridors will not solve this problem, but will help ameliorate the effects. Note: The State of Tennessee mandates an undisturbed 30- or 60-foot stream buffer on all waters of the state, which includes everything except wet weather conveyances (ditches).

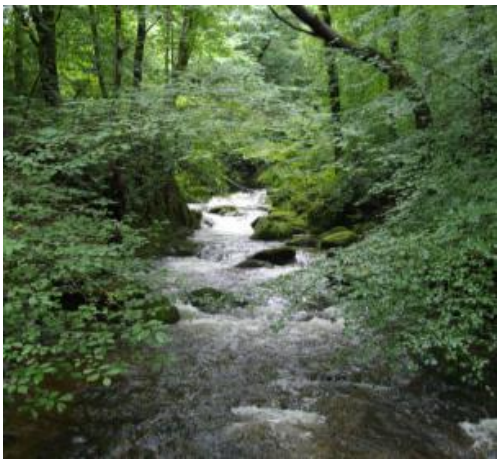

Figure 5.2.3-2. Stream with a continuous riparian corridor.

A healthy riparian corridor in the southeastern United States is fully vegetated, with an unbroken band of native trees, shrubs, ferns, and wildflowers or well-established tall grasses. Plant communities along the margins of watercourses/bodies are called "riparian vegetation." This vegetation must tolerate occasional flooding and occasionally saturated soils. However, riparian corridors generally are not wetlands and the vegetative cover generally is not wetland vegetation, although wetlands can be found

in riparian buffer zones. When lawn is the only vegetation in the riparian zone, it adds to the amount of stormwater runoff that reaches the stream. With a shallow root system, lawn grasses cannot stabilize the bank or perform other stormwater functions.

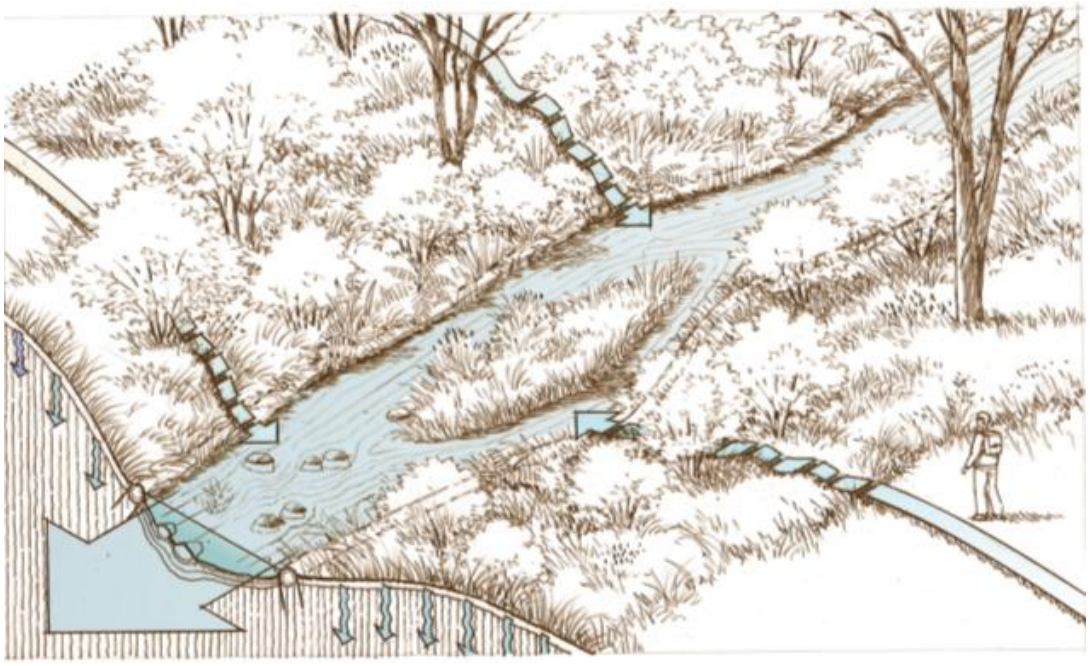

Figure 5.2.3-3. Riparian corridor – healthy.

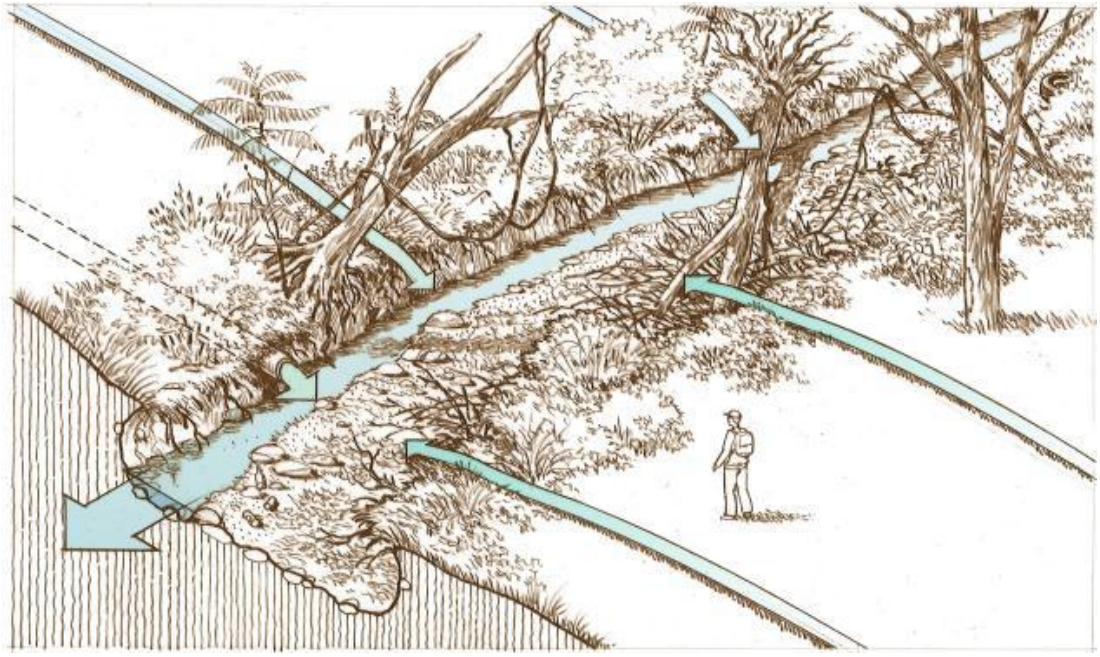

Figure 5.2.3-4. Riparian corridor – unhealthy.

Table 5.2.3-1. Table of Characteristics – Stable vs. Unstable Streams

Stable Stream	Unstable Stream
Constant cross-sectional area and bed elevation	Irregularities in cross-sectional area and bed elevation
Low streambank erosion	Severe streambank erosion
Sloping banks with vegetation	Vertical banks with no vegetation
Floodplain	Floodplain no longer available

It should also be noted that riparian corridors are not floodplains. Although riparian corridors occur within the floodplain, floodplains typically extend well beyond riparian corridors.

BMP Functions Table

BMP	Applicability	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation	Maintenance Burden	Cost
Protect and Enhance Riparian Corridors	U/S/R	H	H	M	L	M	M	H	L	L

KEY: U = Urban; S = Suburban; R = Rural; H = High; M = Medium; L = Low

A healthy, continuous strip of vegetation adjacent to waterbodies large and small (i.e., a riparian corridor) performs many valuable stormwater management functions:

Water Quality Benefits

- Intercepts, absorbs, and filters out excess nutrients, sediments, and pollutants.
- Reduces volume and velocity of stormwater runoff, absorbing surface water runoff and slowing water velocity, which reduces bank cutting and deposition.
- Increases structural stability of the stream banks and reduces siltation.
- Riparian buffers store floodwaters within backwater channels. These channels intercept overland flow before it reaches the main stem. The increase in runoff travel time helps reduce flood peaks.

Additional Ecosystem Health Benefits

- Creates shade, which lowers water temperature and increases the ability of the water to hold greater amounts of dissolved oxygen.
- With less turbidity (muddy water) and cooler temperatures, the dissolved oxygen content of the water can be higher to support a diverse and stable aquatic ecosystem.
- Provides woody debris, detritus, and other organic materials that form the basis of food webs for fresh water aquatic organisms. Fallen, woody vegetation provides substrates for insects, and food and shelter for a variety of fish, reptiles, amphibians, birds, and small mammals. “Snags” (dead, standing timber) can be used for shelter and nesting areas.
- The corridor itself furnishes a visual and noise buffer from surrounding development and offers protected movement routes and habitat for animals.

Encroachment into a riparian corridor or removal of either the canopy trees or the understory layers of vegetation can negatively affect any or all of these important functions. Protecting existing riparian corridors is an important and low-cost BMP.

Key Design Guidelines

- Identify watercourses and their riparian corridors on a site. A surveyor should locate a water channel accurately on the site survey. The surveyor (or qualified person) should also note the extent and plant type (trees, shrubs, grasslands, etc.) of existing vegetation along these corridors.
- Designate the proposed riparian corridor(s) and design to minimize impact of buildings, roads, parking, etc.
- Find design solutions that minimize the need to encroach on or fragment the designated riparian corridor.
- During construction, protect watercourses and their riparian corridors, especially those with undisturbed soil and natural woody vegetation. Every effort should be made to ensure that trees, shrubs, and existing tall grass and wildflower meadows are not damaged or removed.
- Identify the methods that will be used during construction to protect the riparian corridor, including construction fencing around areas to be protected, with site access routes located to avoid or minimize crossing this area. In addition, do not locate a storage area or vehicle parking area, or dump construction debris, within a riparian corridor zone. Trampling, depositing trash, and spilling toxic materials, etc., should also be prohibited within the riparian zone.

Advantages

- Healthy riparian corridors are the base of the food chain for aquatic life.
- Management of runoff in the headwaters is the most effective.
- See Water Quality Benefits and Additional Ecosystem Health Benefits described in the previous paragraphs.
- Avoids the need for ARAP and 404 permits, and avoids difficulty and cost of stream mitigation measures.

Disadvantages

- Requires early determination in concept stage and may present challenges to the status quo.
- Buffers and protective measures may limit physical or visual access to the waterbody.

Applications

Riparian buffers exist in a variety of landscape settings, including agricultural, forested, suburban, and urban areas. Open watercourses and their buffering vegetation can be preserved and integrated into any type of site or any type of site use.

Figure 5.2.3-5. Urban Example – Cheonggyecheon River Restoration Project.

Figure 5.2.3-6. Suburban Example – Brownstone Creek Project.

Applicable Protocols and Specifications

Protocol 5 Planting Guidelines

Design Considerations

Site Analysis

The site survey must locate any watercourse and remaining riparian vegetation existing onsite.

When analyzing a stretch of riparian zone, consider the stream and riparian zone as a **system** that is affected by watershed conditions. The extent, health, and sources of erosion along a riparian stretch are directly related to its watershed and stream characteristics. An analysis of stream and watershed conditions should include historical information on land use changes, hydrologic conditions, and natural disturbances that might influence stream behavior. It should anticipate the changes most likely to occur or that are planned for in the near future.

Items to consider that will influence protection or enhancement of the riparian buffer include:

- Watershed Data
  - History of land use, prior stream modifications, past stability problems, and previous treatments.
  - Overland drainage area that flows to the riparian buffer.
  - Outlets (if any) that discharge into the riparian buffer or stream.

- Cause and Extent of Erosion Problems
  - The degree of degradation of the existing corridor. Many urban streams are severely impacted by upstream development. Stream bank restoration may be needed before protection of the riparian corridor.
    - If bank failure problems are the result of widespread bed degradation/headcutting or aggradation (excessive deposition), determine what triggered the problem.
  - Signs of disturbance or erosion. Visually inspect the corridor, and if erosion problems are localized, determine the cause of erosion at each site.
- Hydrologic Data
  - Physical extent, average occurrence, and duration of flooding events.
- Stream Order
  - Location within the watershed. Headwater vs. 12th order streams act very differently and have different floodplain forms and extents.
- Soils and Geology
  - Gradient and orientation (e.g., north-facing) of slopes that exist within the buffer itself and the adjacent contributing watershed.
  - Slope and formation of floodplain and any modifications that have been made to it.
  - Soil type.
  - Depth to water table.
- Vegetative Condition
  - Type and extent of vegetation found on the banks and within the floodplain. Show the extent of this vegetation and note health and whether this vegetation includes trees, shrubs, or tall grasses.
  - Extent and types of invasive species.
- Habitat characteristics
  - The least-understood aspect of designing and analyzing protection measures is often the impact of the protective measures on in-stream and riparian habitats. Commonly, each stage of the lifecycle of aquatic species requires different habitats, each having specific characteristics. These diverse habitats are needed to meet the unique demands imposed by spawning and incubation, summer rearing, and overwintering. The productivity of most aquatic systems is directly related to the diversity and complexity of available habitats.

<u>Corridor Sizing</u>

The City's MS4 Permit specifies the following standards for riparian buffers:

> "Streams or other waters with drainage areas less than 1 square mile will require buffer widths of 30 feet minimum. Streams or other waters with drainage areas greater than 1 square mile will require buffer widths of 60 feet minimum. The 60-feet criterion

for the width of the buffer zone can be established on an average width basis at a project, as long as the minimum width of the buffer zone is more than 30 feet at any measured location. The MS4 must develop and apply criteria for determining the circumstances under which these averages will be available. A determination that standards cannot be met may not be based solely on the difficulty or cost associated with implementation." – MS4 Permit Language

In determining the appropriate and necessary riparian buffer, the above MS4 standards will be considered the baseline requirement. However, the following USDA methodology may be determined appropriate and necessary given the site-specific conditions and watershed conditions.

Although the U.S. Army Corps of Engineers has specific guidelines to delineate jurisdictional wetlands, there are no standardized criteria to delineate the boundaries of riparian corridors. As a result, there is widespread confusion, among scientists and in the literature, about the appropriate size and configuration of these corridors. Studies suggest that a minimum of 50 feet (on both sides of a stream) is necessary for bank stabilization and that 100 feet (on both sides of a stream) is actually needed to filter runoff.

However, the designer should consider adjacent land uses. Site program and adjacent land uses affect decisions about buffer width and choice of vegetation. While a three-zone riparian buffer (described below) is the most effective solution, it may not be suitable for all sites (particularly dense urban areas or tight campuses).

USDA proposes that riparian buffers be designed/restored in three zones:

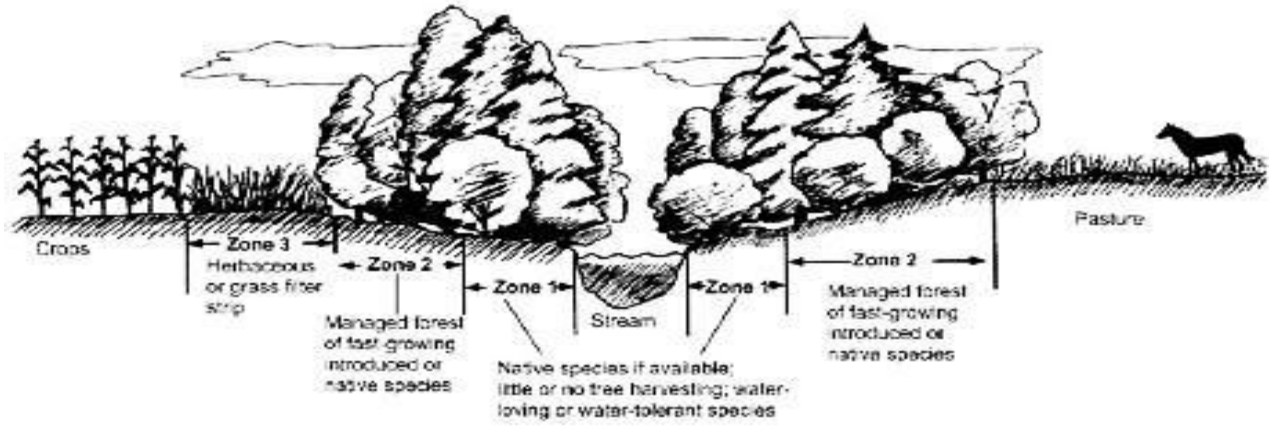

Figure 5.2.3-7. USDA buffer zones.

- Zone 1: Mature forest extending undisturbed for at least 10 to 15 feet from the waterbody edge.
  - Used to provide stream bank and channel stabilization with shading from the tree canopy used to decrease the water temperature. Cooler water temperatures, fallen logs, and leaves provide an environment conducive to certain aquatic life, especially macro-invertebrates, which act as a vital link in the food chain between producers and higher organisms such as fish. Leaves, twigs, and branches that fall from forest trees into the stream are an important source of food and shelter for aquatic macro-invertebrates.

- Zone 2: A layer of managed forest that extends upland from Zone 1 for a minimum of 50 to 60 feet.
  - Where shallow groundwater flows through the root zones of trees, nitrate removal can occur as the trees uptake the nutrients. Trees, vegetation, and fallen organic debris slow stormwater runoff and capture sediment, nutrients, and chemical pollution, allowing the runoff to infiltrate into the ground. Intermittent harvesting of trees is necessary in Zone 2 to encourage rapid tree growth and to remove nutrients that have been sequestered, if it is a concern.

- Zone 3: The first phase in mitigating stormwater runoff, Zone 3 should be a 10- to 20-foot strip of non-forested buffer, located upland of Zone 2.
  - The main function of this zone is to spread concentrated flow before it reaches Zone 2. Some initial infiltration and pollutant removal also occur in Zone 3.
  - Buffers, especially dense grassy or herbaceous buffers on gradual slopes, intercept overland runoff, trap sediments, remove pollutants, and promote groundwater recharge. For low to moderate slopes, most filtering occurs within the first 10 to 20 feet, but greater widths are necessary for steeper slopes.

Design Strategies

- Every effort should be made to keep, protect, and expand riparian corridors, especially those with undisturbed soil and mature woody vegetation. All efforts should be made to ensure that the trees, shrubs, native grasses, and ground covers are protected from damage during construction.
  - Protection of continuous buffers should be given higher priority than protection of piecemeal/fragmented buffers.
  - Buffers should be prioritized by stream order. Establishment of riparian buffers along headwater or source water streams should be given the highest priority. Small

Figure 5.2.3-8. Before stream and buffer restoration.

streams are more easily impacted by land development, and headwater streams cover the majority of the watershed and influence all downstream stormwater management issues.

Figure 5.2.3-9. After stream and buffer restoration.

- In the Army Corp of Engineer's publication, "Design Recommendations for Riparian Corridors and Vegetated Buffer Strips" (Fisher et al. 2000) (http://el.erdc.usace.army.mil/elpubs/pdf/sr24.pdf), the authors provide the following general recommendations for corridor restoration and management:
  - Corridors that maintain or restore natural connectivity are better than those that link areas historically unconnected.
  - Continuous corridors are better than fragmented corridors.
  - Wider corridors are better than narrow corridors.
  - Several corridor connections are better than a single connection.
  - Structurally diverse corridors are better than structurally simple corridors.
  - Native vegetation is better than non-native vegetation.
- Examine the proposed site program and plans. Make all possible efforts to avoid encroaching on the riparian corridor. Find design solutions that minimize the need for proposed site structures, roads, and parking lots to cross or encroach on the watercourse and its vegetative buffer.
- Designate a continuous strip on both sides of perennial or intermittent streams. A riparian corridor should be designated even if the existing vegetation is fragmented or entirely removed.
  - It is desirable to leave a buffer strip of at least 4 feet on either side of any swale, manmade channel, or tiny (1 foot to 18 inches) watercourse (see Section 5.4.1.1, Naturalize Swales and Drainage Channels).
- On the concept plan, identify the methods that will be used before, during, and after construction to protect the riparian corridor. On the final plans and construction drawings, show details and specifications if using methods unfamiliar to local contractors.
  - Divert sediment-laden stormwater from the construction site away from the riparian buffer.
  - Dissipate any concentrated flow using a level spreader, or similar tool. Sheet flow is preferred.
- Do not use permeable paving in a riparian zone—permeable paving is ineffective within any area of high water table or area that floods regularly, as stormwater is unable to infiltrate into the ground.
- If walks or structures are required in this area, consider keeping them off the ground, e.g., use boardwalks with pile foundations.
- Provide a plan to stabilize any bare soil areas and replant where vegetation is damaged, missing, dying, or invasive.

- To encourage the regrowth of native vegetation where the designated corridor was previously in turf or bare soil, remove the turf, loosen compacted soil to a depth of 6 inches, and rake soil smooth. Cover bare soil areas with straw or leaf litter to a depth of no more than 1½ inches. Then cover mulch with a single sheet of "Dutch" (open weave) burlap. Stake burlap with wooden stakes to hold. Plant through the burlap, and then cover burlap with a second thin layer of leaves or straw.
- Save any removed existing woody vegetation and store it so that it may be used later in the project for bioengineering if needed.

- Utilize the ability of riparian buffers to assist in pollutant removal. Appropriately sized riparian buffers have the greatest ability to remove pollutants, nutrients, and sediment loading.

Bioengineering Strategies

Bioengineering uses a system of living plant materials as structural components to mitigate erosion and restore planting. Adapted types of woody vegetation (shrubs and trees) are initially installed in specified configurations that offer immediate soil protection and reinforcement. In addition, bioengineering systems create resistance to erosion as they develop roots or fibrous inclusions.

Chapter 16 of the USDA NRCS Engineering Field Handbook describes the following bioengineering techniques and provides guidance for the implementation of these techniques: http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17553.wba.

- Live stakes
- Live fascines
- Branchpacking
- Vegetated geogrid
- Live cribwall
- Joint planting
- Brushmatress
- Tree revetment
- Rootwards
- Dormant post
- Piling revetment
- Slotted board fence
- Concrete
- Wooden jack field
- Coconut fiber roll
- Stream jetty
- Stream barb
- Vegetated rock gabion details
- Live siltation construction
- Reed clump

Construction Considerations

Damages to existing riparian buffers can be limited by:

- Using small equipment and hand labor.
- Limiting access.
- Locating staging areas outside work area boundaries.
- Not trampling, depositing trash, or spilling toxic materials, etc., within the buffer or within the buffer's immediate drainage area.

- Avoiding or altering construction procedures during critical times, such as fish spawning or bird nesting periods.
- Coordinating construction along a stream that involves more than one job or ownership.
- Scheduling construction activities to avoid expected peak flood season(s).

Construction Sequencing

- Stake out proposed riparian buffer before construction.
- Stake out the location and configuration of construction access, turnarounds, parking, and storage of materials (including soil stockpiles and dumps) from the construction plan.
- Divert construction runoff from riparian buffer areas.
- At the end of construction, carefully match grades from the developed areas meeting the riparian corridor and stabilize all bare soil.

Operations and Maintenance

In general, the least expensive management of riparian corridors is with large-scale measures, modeled on local, natural processes, such as controlled burns and periodic flooding. In addition, broad-brush measures to remove invasive exotics, selective thinning of native vegetation, and replanting either meadow or woodland can help to create riparian buffers that manage stormwater most effectively and are attractive components of the landscape. If designing a corporate or residential community (including retirement complexes), consider having the tenants manage for wildlife. Specific maintenance issues are addressed below:

- Do not harvest trees in Zone 1; dead wood in the stream provides important food for microorganisms in a healthy aquatic system.
- Zones 2 and 3 should be managed to prevent takeover by exotic, invasive vegetation (especially smothering vines) or by a single, aggressive native species.
- Protect Zones 1 and 2 from runoff channeled by swales. Use a level spreader, or similar tool, in the meadow (Zone 3) to convert concentrated flow to sheet flow. Any level spreader or similar tool used should be inspected periodically to repair any developing rills or standing pools of water. Sediment and debris should be removed from below the level spreader semiannually.
- On larger campuses, parks, subdivisions etc., some sort of farm or ranch fencing may be desirable around the perimeter of Zone 3 to protect from damage (loss of vegetation and compaction) by vehicular traffic or pedestrians.
- In areas overrun by white-tailed deer, deer fencing (18 feet high open, wire or plastic) may be necessary. Alternate deer management could involve organized “culls” or private bow-hunting permits. Damage to Zone 3 will limit the buffer’s ability to spread out concentrated flow and to filter nutrients, sediments, toxins, etc.
- Watering during the establishment period (first growing season) will be necessary if there are new plantings.

- Any level spreading device used to ensure that concentrated flow is spread into sheet flow should be inspected periodically for any channelization or standing pools of water below the level spreader. Sediment and debris should be removed semiannually.

All three zones should be periodically inspected for evidence of gully formation after large storms, denuded areas, and bare soil, or any other signs of damage. Gullies should be filled and regraded, and bare spots replanted and protected.

Resources

The USDA Forest Service has developed a riparian buffer specification and guidance, which can be accessed at the following link: http://www.na.fs.fed.us/spfo/pubs/n_resource/buffer/cover.htm.

The USDA Natural Resource Conservation Service has a good resource for stream bank protection (a specific part of the riparian buffer) that includes planting techniques and selections in Chapter 16 of its Engineering Field Handbook, which can be downloaded here: http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17553.wba.

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Criteria Checklist BMP 5.2.3

ITEM DESCRIPTION	YES	N/A
The following checklist provides a summary of design guidance by the owner/applicant for successful implementation.		
• Concept level site analysis includes watershed data, cause and extent of erosion problems, hydrologic data, stream order of all streams, soils and geology data, vegetative condition, and habitat characteristics. Photo documentation is required.	☐	☐
• The required size of the riparian corridor has been established and has been designated a "Protected Area."	☐	☐
• Protected areas are delineated clearly on the Existing Conditions Assessment, Site Protection Plan, Grading and Soils Plan, Erosion and Sediment Control Plan, and Stormwater Plan.	☐	☐
• Protected areas are safeguarded from sediment and stormwater loads during construction.	☐	☐
• Protection, fencing details, and associated signage details for protected areas have been provided.	☐	☐
• If construction activity is necessary within riparian protected area, activities are noted and outlined in sequence (include a description of the activity, why necessary, and proposed time of year/ month of activity).	☐	☐
• If activity is necessary within riparian protected area, remediation activities are outlined in the specifications and drawings.	☐	☐
• Disturbance within riparian corridor avoided or design solutions were utilized to minimize encroachment on the corridor.	☐	☐
• Proposed planting plan of corridor enhancement is appropriate for the three zones of the riparian corridor.	☐	☐
• Permeable paving was not utilized in the riparian zone.	☐	☐
• If walks and structures are proposed in the riparian zone, their footprint was minimized (e.g., pile foundations).	☐	☐
• Bioengineering techniques were utilized within the riparian zone to protect eroding slopes and/or sloped areas.	☐	☐