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RUNOFF CONTROL MEASURES

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TEMPORARY DIVERSIONS

Definition

A temporary ridge or excavated channel or combination ridge and channel constructed across sloping land on a predetermined grade.

Purpose

To protect work areas from upslope runoff, and to divert sediment-laden water to appropriate traps or stable outlets.

Conditions Where Practice Applies

This practice applies to construction areas where runoff can be diverted and disposed of properly to control erosion, sedimentation, or flood damage. Specific locations and conditions include:

- above disturbed existing slopes, and above cut or fill slopes to prevent runoff over the slope;
- across unprotected slopes, as slope breaks, to reduce slope length;
- below slopes to divert excess runoff to stabilized outlets;
- where needed to divert sediment-laden water to sediment traps;
- at or near the perimeter of the construction area to keep sediment from leaving the site; and
- above disturbed areas before stabilization to prevent erosion, and maintain acceptable working conditions.
- Temporary diversions may also serve as sediment traps when the site has been overexcavated on a flat grade; they may also be used in conjunction with a sediment fence.

Planning Considerations

It is important that diversions are properly designed, constructed and maintained since they concentrate water flow and increase erosion potential (Figure 6.20a). Particular care must be taken in planning diversion grades. Too much slope can result in erosive velocity in the diversion channel or at the outlet. A change of slope from steeper grade to flatter may cause deposition to occur. The deposition reduces carrying capacity, and may cause overtopping and failure. Frequent inspection and timely maintenance are essential to the proper functioning of diversions.

Sufficient area must be available to construct and properly maintain diversions. It is usually less costly to excavate a channel and form a ridge or dike on the

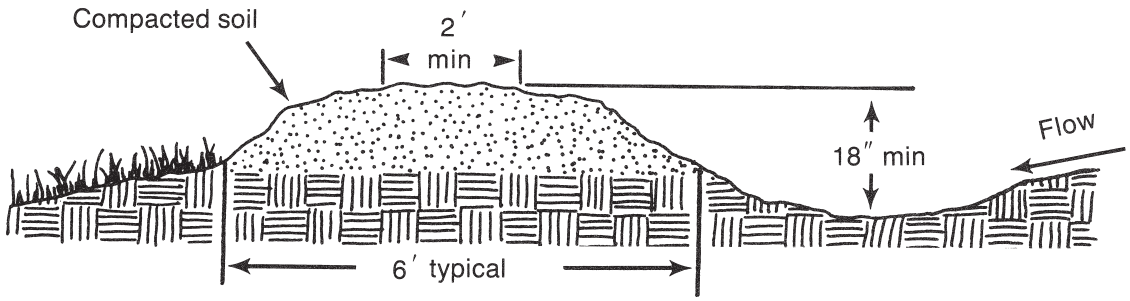

Figure 6.20a Temporary earthen diversion dike.

downhill side with the spoil than to build diversions by other methods. Where space is limited, it may be necessary to build the ridge by hauling in diking material, or using a silt fence to divert the flow. Use gravel to form the diversion dike when vehicles must cross frequently (Figure 6.20b).

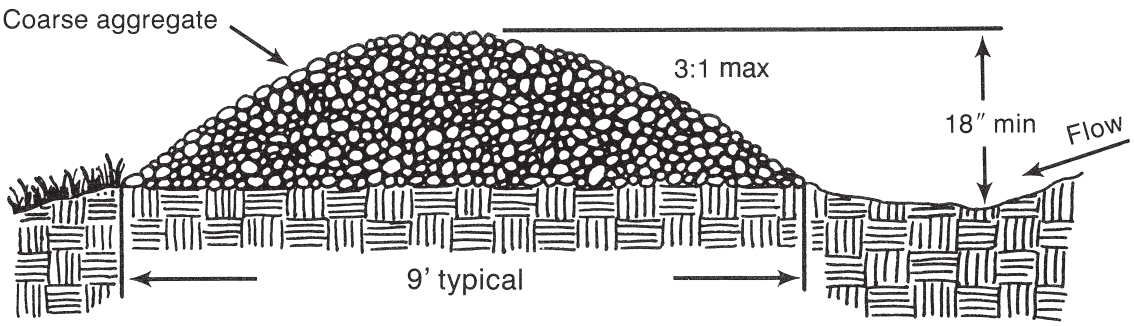

Figure 6.20b Temporary gravel diversion dike for vehicle crossing (modified from Va SWCC).

Plan temporary diversions to function 1 year or more, or they may be constructed anew at the end of each day's grading operation to protect new fill. Diversions that are to serve longer than 30 working days should be seeded and mulched as soon as they are constructed to preserve dike height and reduce maintenance.

Where design velocities exceed 2 ft/sec, a channel liner is usually necessary to prevent erosion (Table 8.05a, *Appendix 8.05*).

Temporary diversions may serve as in-place sediment traps if overexcavated 1 to 2 feet and placed on a nearly flat grade. The dike serves to divert water as the stage increases. A combination silt fence and channel in which fill from the channel is used to stabilize the fence can trap sediment and divert runoff simultaneously.

Wherever feasible, build and stabilize diversions and outlets before initiating other land-disturbing activities.

Design Criteria

Drainage area—5 acres or less.

Capacity—peak runoff from 10-year storm.

Velocity—See Table 8.05a, Permissible Velocities for Erosion Protection, Appendix 8.05.

Ridge design—

side slope:	2:1 or flatter
	3:1 or flatter at points where cross
top width:	2 ft minimum
freeboard:	0.3 ft minimum
settlement:	10% of total fill height minimum

Channel design— shape: parabolic, trapezoidal, or V-shaped
side slope: 2:1 or flatter
3:1 or flatter where vehicles cross

Grades— Either a uniform or a gradually increasing grade is preferred. Sudden decreases in grade accumulate sediment and should be expected to cause overtopping. A large increase in grade may erode.

Outlet—Design the outlet to accept flow from the diversion plus any other contributing areas. Divert sediment-laden runoff and release through a sediment-trapping device (Practice 6.60, *Temporary Sediment Trap* and Practice 6.61, *Sediment Basin*). Flow from undisturbed areas can be dispersed by a level spreader (Practice 6.40, *Level Spreader*).

Small diversions—Where the diversion channel grade is between 0.2 and 3%, a permanent vegetative cover is required. A parabolic channel and ridge 1.5 feet deep and 12 feet wide may be used for diversions with flows up to 5 cfs. This depth does not include freeboard or settlement. Side slopes should be 3:1 or flatter, and the top of the dike must be at least 2 feet wide.

Construction Specifications

1. Remove and properly dispose of all trees, brush, stumps, and other objectionable material.

2. Ensure that the minimum constructed cross section meets all design requirements.

3. Ensure that the top of the dike is not lower at any point than the design elevation plus the specified settlement.

4. Provide sufficient room around diversions to permit machine regrading and cleanout.

5. Vegetate the ridge immediately after construction, unless it will remain in place less than 30 working days.

Maintenance

Inspect temporary diversions once a week and after every rainfall. Immediately remove sediment from the flow area and repair the diversion ridge. Carefully check outlets and make timely repairs as needed. When the area protected is permanently stabilized, remove the ridge and the channel to blend with the natural ground level and appropriately stabilize it.

References

Surface Stabilization
6.10, Temporary Seeding
6.11, Permanent Seeding
6.14, Mulching

Outlet Protection
6.40, Level Spreader
6.41, Outlet Stabilization Structure

Sediment Traps and Barriers
6.60, Temporary Sediment Trap
6.61, Sediment Basin

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8.03, Estimating Runoff
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→ D →

PERMANENT DIVERSIONS

Definition

A permanent ridge or channel or a combination ridge and channel constructed on a designed grade across sloping land.

Purpose

To divert water from areas where it is in excess to locations where it can be used or released without erosion or flood damage.

Conditions Where Practice Applies

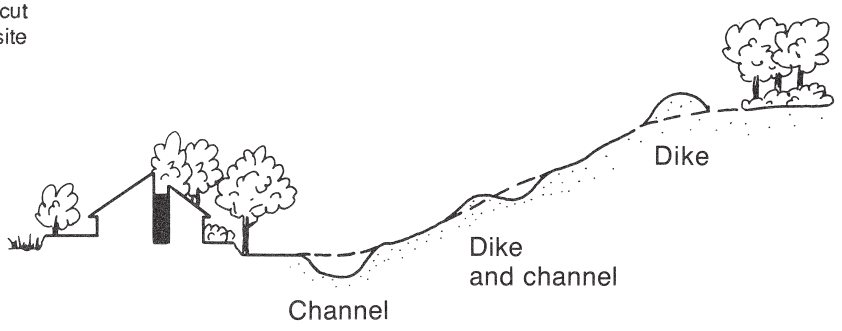
This permanent site development practice applies to construction areas where runoff can be diverted and used or disposed of safely to prevent flood damage or erosion and sedimentation damage. Specific locations and conditions include:

- above steep slopes to limit surface runoff onto the slope;
- across long slopes to reduce slope length to prevent gully erosion;
- below steep grades where flooding, seepage problems, or sediment deposition may occur;
- around buildings or areas that are subject to damage from runoff.

Planning Considerations

Permanent diversions should be planned as a part of initial site development. They are principally runoff control measures that subdivide the site into specific drainage areas (Figure 6.21a). Permanent diversions can be installed as temporary diversions until the site is stabilized then completed as a permanent measure, or they can be installed in final form during the initial construction operation (Practice 6.20, *Temporary Diversions*). The amount of sediment anticipated and the maintenance required as a result of construction operations will determine which approach should be used. Stabilize permanent diversions with vegetation or materials such as riprap, paving stone, or concrete as soon as possible after installation. Base the location, type of stabilization, and diversion configuration on final site conditions. Evaluate function, need, velocity control, outlet stability, and site aesthetics. When properly located, land forms such as landscape islands, swales or ridges can be used effectively as permanent diversions. Base the capacity of a diversion on the runoff characteristics of the site and the potential damage after development. Consider designing an emergency overflow section or bypass area to limit damage from storms that exceed the design storm. The overflow section may be designed as a weir with riprap protection.

Figure 6.21a Use of diversions to protect cut or fill slopes, protect structures or off-site property, or break long slopes.



Design Criteria

Location—Determine diversion locations by topography, development layout, soil conditions, outlet conditions, length of slope, seepage planes, and need for water and sediment storage.

Capacity—Ensure that permanent diversions have sufficient capacity to carry the peak runoff expected from a storm frequency consistent with the hazard involved, as shown in Table 6.21a.

Velocity—See Table 8.05a, *Appendix 8.05*.

Ridge design—	side slope:	2:1 or flatter 3:1 or flatter when maintained by mowing
	top width:	2 feet minimum
	freeboard:	0.5 feet minimum
	settlement:	10% of total fill height minimum
Channel design—	material:	to meet velocity requirements and site aesthetics
	shape:	to fit site conditions
	side slope:	2:1 or flatter 3:1 or flatter when maintained by mowing

Grades—Either a uniform or a gradually increasing grade is preferred.

Outlet—Design the outlet stable enough to accept flow from the diversions plus any other contributing runoff. Divert sediment-laden runoff and release it through a sediment-trapping device (Practice 6.60, *Temporary Sediment Trap*, or Practice 6.61, *Sediment Basin*).

Stabilization—Unless the area is otherwise stabilized, provide vegetative stabilization after installation of the diversion. Seed and mulch disturbed areas draining into the diversion within 21 calender days of completing any phase of grading.

Table 6.21a
Minimum Design Storm for Degrees of Hazard

Level of Protection	Area to Be Protected	Minimum Design Storm
Low	All erosion control facilities. Open areas, parking lots, minor recreation areas.	10 year
Medium	Recreation development, low-capacity roads and minor structures.	25 year, 24 hour 50 year, 24 hour
High	Major structures, homes, main school buildings, high-capacity roads.	100 year, 24 hour

Construction Specifications

1. Remove and properly dispose of all trees, brush, stumps, or other objectionable material. Fill and compact all ditches, swales, or gullies that will be crossed to natural ground level or above.

2. Just before placement of fill, the base of the ridge should be disked by machinery.

3. Excavate, shape, and stabilize the diversion to line, grade, and cross section, as required in the design plan (Figure 6.21b).

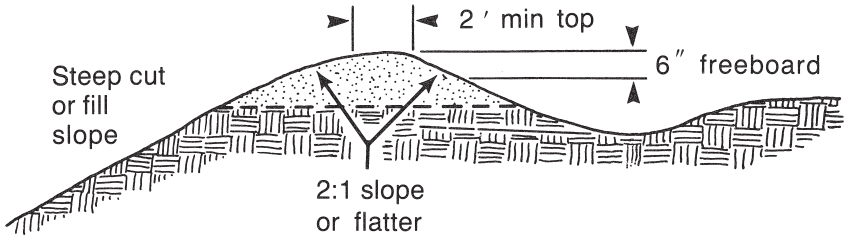


Figure 6.21b Permanent diversion located above a slope.

4. Compact the ridge to prevent unequal settlement, and to provide stability against seepage.

5. Vegetatively stabilize the diversion after its installation.

Maintenance

Inspect permanent diversions after every rainfall during the construction operation. Immediately remove any obstructions from the flow area, and repair the diversion ridge. Check outlets, and make timely repairs as needed. Maintain the vegetation in a vigorous, healthy condition at all times.

References

Surface Stabilization
6.10, Temporary Seeding
6.11, Permanent Seeding
6.14, Mulching

Runoff Control Measures
6.20, Temporary Diversions

Outlet Protection
6.40, Level Spreader
6.41, Outlet Stabilization Structure

Sediment Traps and Barriers
6.60, Temporary Sediment Trap
6.61, Sediment Basin

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8.03, Estimating Runoff
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→ PD →

DIVERSION DIKE (Perimeter Protection)

Definition

A dike or dike and channel constructed along the perimeter of a disturbed construction area.

Purpose

To prevent storm runoff from entering the work area, or to prevent sediment-laden runoff from leaving the construction site.

Conditions Where Practice Applies

Diversion dikes may be located at the upslope side of a construction site to prevent surface runoff from entering the disturbed area or at the downslope side of the work area to divert sediment-laden runoff to on-site sediment traps or basins. Diversion dikes do not usually encircle the entire area.

The upslope dike can improve working conditions at the construction site and prevent erosion. The downslope dike assures that sediment-laden runoff will not leave the site without treatment.

Planning Considerations

A diversion dike is a special application of a temporary or permanent diversion. It differs from other diversions in that the location and grade are usually fixed, and the cross section and stabilization requirements are based on the existing grade of the work boundary. Hence, the design cross section may vary significantly throughout the length. Give special care to avoid erosive velocities in steep areas. Identify areas where sedimentation will occur since they are often subject to overtopping.

Immediately vegetate diversion dikes after construction, but make sure channel flow area is stabilized during construction. Exercise caution in diverting flow to be certain that the diverted water is released through a stable outlet and that the flow will not cause flood damage. Diversion dikes may be either temporary or permanent depending on site conditions (Figure 6.22a).

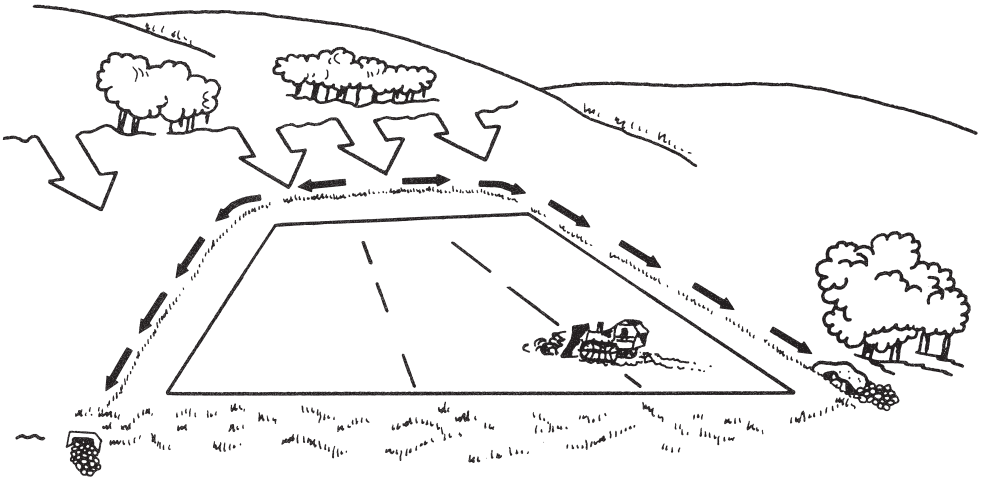

Figure 6.22a Perimeter dikes prevent surface runoff from entering construction sites.

Design Criteria

Drainage area—5 acres or less.

Capacity—consistent with the hazard involved and design life and with a 10 year peak runoff minimum.

Velocity—See Table 8.05a, *Appendix 8.05*.

Dike design—	side slope:	2:1 or flatter
		3:1 or flatter where vehicles must cross
	width:	2.0 feet minimum top width
	height:	1.5 feet minimum
	freeboard:	0.5 feet minimum
	settlement:	10% of total fill height minimum
Channel design—	shape:	parabolic, trapezoidal, or V-shaped
	side slope:	2:1 or flatter
		3:1 or flatter where vehicles must cross
	stabilization:	based on velocity by reaches

Grade—Dependent on site topography. Channel should have positive grade.

Outlet—Divert sediment-laden water into a temporary sediment trap or sediment basin. Runoff from undisturbed areas should empty into an outlet protection device such as a level spreader or riprap outlet structure unless well stabilized natural outlets exist.

Construction Specifications

1. Remove and properly dispose of all trees, brush, stumps, and other objectionable material. Fill and compact, to natural ground level or above, all ditches and gullies that will be crossed by machinery.

2. Disk the base of the dike before placing fill.

3. Ensure that the constructed cross section meets all design requirements.

4. Compact the dike by tracking with construction equipment.

5. Ensure that the top of the dike is not lower at any point than the design elevation plus the specified settlement after it has been compacted.

6. Leave sufficient area along the dike to permit machine re-grading and cleanout.

7. Immediately seed and mulch the dike after its construction, and stabilize the flow portion in accordance with design requirements.

Maintenance

Inspect diversion dikes once a week and after every rainfall. Immediately remove sediment from the flow area and repair the dike.

Check outlets, and make timely repairs as needed to avoid gully formation. When the area above the temporary diversion dike is permanently stabilized, remove the dike, and fill and stabilize the channel to blend with the natural surface.

References

Surface Stabilization
- 6.10, Temporary Seeding
- 6.11, Permanent Seeding
- 6.14, Mulching

Outlet Protection
- 6.40, Level Spreader
- 6.41, Outlet Stabilization Structure

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- 8.05, Design of Stable Channels and Diversions

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→ WB →

RIGHT-OF-WAY DIVERSIONS (Water Bars)

Definition

A ridge or ridge and channel constructed diagonally across a sloping road or utility right-of-way that is subject to erosion.

Purpose

To limit the accumulation of erosive volumes of water by diverting surface runoff at predesigned intervals.

Conditions Where Practice Applies

Where runoff protection is needed to prevent erosion on sloping access rights-of-way or other long, narrow sloping areas generally less than 100 feet in width.

Planning Considerations

Construction of access roads, power lines, pipelines, and other similar installations often requires clearing long narrow rights-of-way over sloping terrain (Figure 6.23a). Disturbance and compaction promotes gully formation in these cleared strips by increasing the volume and velocity of runoff. Gully formation may be especially severe in tire tracks and ruts. To prevent gullying, runoff can often be diverted across the width of the right-of-way to undisturbed areas by using small predesigned diversions. Give special consideration to each individual outlet area, as well as to the cumulative effect of added diversions. Use gravel to stabilize the diversion where significant vehicular traffic is anticipated.

Design Criteria

Height—18-inch minimum measured from the channel bottom to the ridge top.

Side slope—2:1 or flatter

3:1 or flatter where vehicles cross

Base width of ridge—6 feet minimum (Figure 6.23b).

Spacing of water bars is shown in Table 6.23a:

Table 6.23a Spacing of Water Bars on Right-of-Way Less than 100 ft Wide

Slope (%)	Spacing (Ft)
<5	125
5 to 10	100
10 to 20	75
20 to 35	50
>35	25

Grade and angle—A crossing angle should be selected to provide a positive grade not to exceed 2%

Outlet—Diversions should have stable outlets, either natural or constructed. Site spacing may need to be adjusted for field conditions to use the most suitable areas for water disposal.

Construction Specifications

1. Install the diversion as soon as the right-of-way has been cleared and graded.

2. Disk the base for the constructed ridge before placing fill.

Figure 6.23a Water bars to protect utility right-of-way.

3. Track the ridge to compact it to the design cross section.

4. Locate the outlet on an undisturbed area. Adjust field spacing of the diversion to use the most stable outlet areas. When natural areas are not deemed satisfactory, provide outlet protection (Practices 6.40, *Level Spreader*, and 6.41, *Outlet Stabilization Structure*).

5. Immediately seed and mulch the portions of the diversions not subject to construction traffic. Stabilize with gravel areas to be crossed by vehicles.

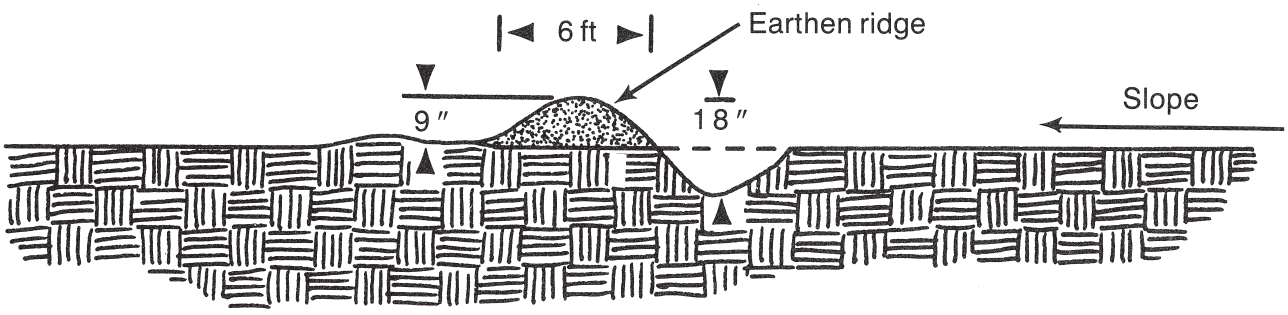

Figure 6.23b Section view of a water bar.

Maintenance

Periodically inspect right-of-way diversions for wear and after every heavy rainfall for erosion damage. Immediately remove sediment from the flow area, and repair the dike. Check outlet areas, and make timely repairs as needed. When permanent road drainage is established and the area above the temporary right-of-way diversions is permanently stabilized, remove the dike, and fill the channel to blend with the natural ground, and appropriately stabilize the disturbed area.

References

Outlet Protection
6.40, Level Spreader
6.41, Outlet Stabilization Structure

Appendix
8.03, Estimating Runoff

6.24 RIPARIAN AREA SEEDING

Definition

Controlling runoff and erosion in riparian areas by establishing temporary annual and perennial native vegetative cover.

Purpose

To protect riparian areas from erosion and decrease sediment yield in adjacent streams using temporary annual vegetation as an immediate cover and establish perennial native herbaceous vegetation.

Conditions Where Practice Applies

Disturbed riparian areas between streams and uplands where permanent herbaceous vegetation is needed to stabilize the soil and provide long-term protection.

Planning Considerations

Native vegetation species are defined as plant species that naturally occur in the region in which they evolved. These plants are adapted to local soil types and climatic variations and generally require little to no maintenance. Many of the species have evolved deep, extensive root structures that help stabilize soils and reduce erosive forces of rainfall and overland stream flow. Native species possess certain characteristics that allow them not only to survive, but also to thrive under local conditions. Further, naturally occurring plant communities provide optimal habitat for terrestrial and aquatic fauna. Other agency permits (i.e., ACOE 404 and DWQ 401) may specify further conditions for establishment of native woody vegetation and limits on use of mechanical equipment.

Seeding a mixture of perennial native grasses, rushes, and sedges is a common way to establish permanent ground cover within riparian areas. Both labor and material costs are lower than installation of propagated plants, though some sites may require installation of established vegetation due to site limitations. Selecting a seed mixture with different species having complementary characteristics will allow vegetation to fill select niches within the varying riparian area and respond to different environmental conditions.

Despite the advantages, several disadvantages of seeding riparian areas with native seed may include:

- Potential for erosion or washout during the establishment stage;
- Longer time for germination and establishment;
- Seasonal limitation on suitable seeding dates;
- Specificity of species at each site;
- Need for water and appropriate temperatures during germination and early growth; and
- Need for invasive plant/competition control.

A temporary, non-invasive, and non-competitive annual grass species should be incorporated with the native seeding. This will provide an immediate cover over the site that serves to:

- Prevent bare soil exposure and hold soil in place; and
- Provide a nurse crop for native seeds while they become established.

Temporary annual species should be planted at a low density so they do not suppress growth of permanent species.

Successful plant establishment can be maximized through good planning, knowledge of soil characteristics, selections of suitable plant species for each site, proper seedbed preparation, and timely planting and maintenance.

Selecting Plant Materials

Permanent seed species within the seed mixture should be selected based on natural occurrence of each species in the project site area. Climate, soils, and topography are major factors affecting the suitability of plants for a particular site and these factors vary widely across North Carolina, with the most significant contrasts occurring among the three major physiographic regions of the state – Mountains, Piedmont, and Coastal Plain. Even within the riparian area, there may be need for different species depending on site conditions (i.e. dry sandy alluvial floodplains with wet pockets). Therefore, thoughtful planning is required when selecting species for individual sites in order to maximize successful vegetation establishment.

Seeds adapted to North Carolina should be purchased from a reputable seed grower and should be certified. Do not accept seed containing "prohibited" noxious weed seed. For successful broadcast seeding, seeds should be cleaned. If warm season grasses with "fluffy" seeds are used, a specialized warm season grass drill should be employed. Cultivars should be selected based on adaptation to site region. Stratification, either naturally or artificially, is required for most native seed species to ensure proper germination.

Table 6.24a provides suitable temporary seed species with recommended application rates and optimal planting dates. Temporary annual seed selection should be based on season of project installation. A single species selection for temporary cover is acceptable. In some cases where seasons overlap, a mixture of two or more temporary species may be necessary; however, application rates should not exceed the total recommended rate per acre. Temporary seed should be mixed and applied simultaneously with the permanent seed mix if optimal planting dates allow.

Table 6.24a Temporary Seeding Recommendations

Common Name	Scientific Name	Rate per Acre	Optimal Planting Dates		
			Mountains	*Piedmont*	*Coastal Plain*
Rye grain	Secale cereale	30 lbs	Aug. 15 - May 15	Aug. 15 - May 1	Aug. 15 - Apr. 15
Wheat	Triticum aestivum	30 lbs	Aug. 15 - May 15	Aug. 15 - May 1	Aug. 15 - Apr. 15
German millet	Setaria italica	10 lbs	May 15 - Aug. 15	May 1 - Aug. 15	Apr. 15 - Aug. 15
Browntop millet	Urochloa ramosa	10 lbs	May 15 - Aug. 15	May 1 - Aug. 15	Apr. 15 - Aug. 15

Tables 6.24b-6.24d provide selections of native permanent seeds based on physiographic regions. Included in these tables are species, cultivars, appropriate percentage rates of mixture, and optimal planting times. **No specific seeding rate is given in order to allow for custom seed mixes based on site characteristics and season. However, permanent seed inclusion in the**

mixture should total 15 pounds of pure live seed (PLS) per acre drilled or 15 to 20 pounds PLS per acre broadcast applied. At least four species should be selected for the mixture, including one species from each type (warm season, cold season, wetland); selection of more than four species is recommended for increasing chances of successful vegetation establishment. If other species such as wildflowers are added to the mix, they should not be counted in the minimum seeding rate for grasses.

Seedbed Preparation

Disturbed soils within riparian areas must be amended to provide an optimum environment for seed germination and seedling growth. The surface soil must be loose enough for water infiltration and root penetration. The pH of the soil must be such that it is not toxic and nutrients are available. Riparian areas are generally considered rich in nutrients due to flooding and deposition, however, these areas can be highly variable (i.e., narrow steep corridors in the mountains, artificial fill material on top of alluvial floodplains in the Piedmont). Soil analysis should be performed to determine nutrient and lime needs of each site. Appropriate levels of phosphorus and potassium are critical for permanent seed establishment. Appropriate pH levels are between 5.5 and 7. Riparian buffers regulated for nutrient management may be limited to a single application of fertilizer.

Construction activities within the riparian area can greatly compact soils. Suitable mechanical means such as disking, raking, or harrowing must be employed to loosen the compacted soil prior to seeding.

Planting

Seeding rates of native herbaceous species are given in pounds of pure live seed due to the variability in the germination and purity of native seed. Reputable seed growers and dealers will buy and sell native seed by the pure live seed pound. When the seed is sown, the amount of pure live seed must be converted to pounds of bulk (actual) seed to sow the proper amount of seed. The amount of bulk (actual) seed is calculated by dividing the amount of pure live seed by the germination and purity as decimals. For example, a ten pound pure live seed per acre seeding rate with seed with 50 percent germination and 50 percent purity will require 40 pounds of bulk (actual) seed (40-10/0.5*0.5).

Planting dates given in the seeding mixture specifications (Tables 6.24b – 6.24d) are designated as “optimal”. Seeds properly sown within the “optimal” dates have a high probability of success. It is also possible to have satisfactory establishment when seeding outside these dates. However, as you deviate from them, the probability of failure increases rapidly. Always take this into account when scheduling land-disturbing activities. Many perennial native species require a cold, wet treatment (stratification) before they will germinate at the rate noted on the seed tag. Seeding before the local date of last frost usually provides enough exposure to cold moist conditions to meet these requirements. Seeding before that date also insures early germination that will decrease the chance that seedlings will be affected by summer droughts. Seed sown late may not germinate until the next year after it has laid in the ground through a winter.

Apply seed uniformly with a cyclone seeder, drop-type spreader, drill, or hydroseeder on a firm, friable seedbed. When using a drill, equipment should be

calibrated in the field for the desired seeding rate. In fine soils, seeds should be drilled ¼ to ½ inch. In coarse sandy soils, seeds should be planted no deeper than ¾ inch. Cover broadcast seed by lightly raking or chain dragging; then firm the surface with a roller or cultipacker to provide good seed contact.

Mulch all plantings immediately after seeding (Practice 6.14, Mulching). If planting on stream banks steeper than 10 percent or areas subject to flooding, a biodegradable RECP (Practice 6.17, Rolled Erosion Control Products) is recommended to hold seed and soil in place.

Table 6.24b Permanent Seeding Recommendations -- Mountain Region

Common Name	Scientific Name	Cultivars	Type*	Percentage of Mix	Optimal Planting Dates	Soil Drainage Adaptation	Shade Tolerance	Height
Switchgrass	Panicum virgatum	**Cave-in-rock --** well drained **Blackwell --** well drained **Shelter --** well drained **Kanlow --** poorly drained **Carthage --** well drained	Warm Season	10-15%	Dec. 1 - Apr. 15	Cultivar Dependent	Poor	6
Indiangrass	Sorghastrum nutans	**Rumsey, Osage, Cheyenne**	Warm Season	10-30%	Dec. 1 - Apr. 15	Well-drained to Droughty	Poor	6
Deertongue	Dichanthelium clandestinum	**Tioga**	Warm Season	5-25%	Dec. 1 - Apr. 15	Poorly-drained to Droughty	Moderate	6
Big Bluestem	Andropogon gerardii	**Roundtree, Kaw, Earl**	Warm Season	10-30%	Dec. 1 - Apr. 15	Well-drained to Droughty	Poor	6
Little Bluestem	Schizachyrium scoparium	**Aldous, Cimarron**	Warm Season	10-30%	Dec. 1 - Apr. 15	Well-drained to Droughty	Poor	4
Sweet Woodreed	Cinna arundinacea		Warm Season	1-10%	Dec. 1 - Apr. 15	Poorly-drained to Well-drained	Moderate	5
Rice Cutgrass	Leersia oryzoides		Warm Season	5-25%	Dec. 1 - Apr. 15	Poorly-drained	Poor	5
Redtop Panicgrass	Panicum rigidulum		Warm Season	10-20%	Dec. 1 - Apr. 15	Well-drained	Poor	3.5
Eastern Gammagrass	Tripsacum dactyloides		Warm Season	10-20%	Dec. 1 - Apr. 15	Well-drained to Poorly-drained	Poor	4.5
Purple top	Tridens flavus		Warm Season	5-10%	Dec. 1 - Apr. 15	Well-drained to Droughty	Poor	2.5
Indian Woodoats	Chasmanthium latifolium		Cold Season	1-10%	Mar. 1 - May 15, July 15 - Aug. 15	Well-drained to Droughty	Moderate	4
Virginia Wildrye	Elymus virginicus		Cold Season	5-25%	Mar. 1 - May 15, July 15 - Aug. 15	Well-drained to Droughty	Moderate	3
Eastern Bottle-brush Grass	Elymus hystrix		Cold Season	5-10%	Mar. 1 - May 15, July 15 - Aug. 15	Well-drained to Droughty	Moderate	3
Winter Bentgrass	Agrostis hyemalis		Cold Season	10-20%	Mar. 1 - May 15, July 15 - Aug. 15	Well-drained	Moderate	3.5
Rough Bentgrass	Agostis scabra		Cold Season	10-20%	Mar. 1 - May 15, July 15 - Aug. 15	Poorly-drained	Poor	2.5
Soft Rush	Juncus effusus		Wetland	1-10%	Dec. 1 - May 15, Aug. 15 - Oct.. 15	Poorly-drained	Poor	4
Shallow Sedge	Carex lurida		Wetland	1-10%	Dec. 1 - May 15, Aug. 15 - Oct.. 15	Poorly-drained	Poor	3
Fox Sedge	Carex vulpinoidea		Wetland	1-10%	Dec. 1 - May 15, Aug. 15 - Oct.. 15	Poorly-drained	Poor	3
Leathery Rush	Juncus coriaceus		Wetland	2-5%	Dec. 1 - May 15, Aug. 15 - Oct.. 15	Poorly-drained	Poor	2

*Pick at least four species, including one from each type.

Table 6.24c Permanent Seeding Recommendations -- Piedmont Region

Common Name	Scientific Name	Cultivars	Type*	Percentage of Mix	Optimal Planting Dates	Soil Drainage Adaptation	Shade Tolerance	Height
Switchgrass	Panicum virgatum	**Blackwell --** well drained **Shelter --** well drained **Kanlow --** poorly drained **Carthage --** well drained	Warm Season	10-15%	Dec. 1 - Apr. 1	Cultivar Dependent	Poor	6
Switchgrass	Panicum virgatum	**Alamo --** poorly-drained	Warm Season	10-15%	Dec. 1 - May 1	Cultivar Dependent	Poor	6
Indiangrass	Sorghastrum nutans	**Rumsey, Osage, Cheyenne**	Warm Season	10-30%	Dec. 1 - Apr. 1	Well-drained to Droughty	Poor	6
Indiangrass	Sorghastrum nutans	**Lometa**	Warm Season	10-30%	Dec. 1 - May 1	Well-drained to Droughty	Poor	6
Deertongue	Dichanthelium clandestinum	**Tioga**	Warm Season	5-25%	Dec. 1 - Apr. 1	Poorly-drained to Droughty	Moderate	2
Big Bluestem	Andropogon gerardii	**Roundtree, Kaw, Earl**	Warm Season	10-30%	Dec. 1 - Apr. 1	Well-drained to Droughty	Poor	6
Little Bluestem	Schizachyrium scoparium	**Cimarron**	Warm Season	10-30%	Dec. 1 - Apr. 1	Well-drained to Droughty	Poor	4
Sweet Woodreed	Cinna arundinacea		Warm Season	1-10%	Dec. 1 - Apr. 1	Poorly-drained to Well-drained	Moderate	5
Rice Cutgrass	Leersia oryzoides		Warm Season	5-25%	Dec. 1 - Apr. 1	Poorly-drained	Poor	5
Redtop Panicgrass	Panicum rigidulum		Warm Season	10-20%	Dec. 1 - Apr. 1	Well-drained	Poor	3.5
Beaked Panicgrass	Panicum anceps		Warm Season	10-20%	Dec. 1 - Apr. 1	Poorly-drained	Moderate	3.5
Purple top	Tridens flavus		Warm Season	5-10%	Dec. 1 - Apr. 1	Well-drained to Droughty	Poor	2.5
Eastern Gammagrass	Tripsacum dactyloides		Warm Season	5-10%	Dec. 1 - Apr. 1	Well-drained to Poorly-drained	Poor	4.5
Indian Woodoats	Chasmanthium latifolium		Cold Season	1-10%	Feb. 15 - Apr. 1, Aug. 15 - Oct. 15	Well-drained to Droughty	Moderate	4
Virginia Wildrye	Elymus virginicus		Cold Season	5-25%	Feb. 15 - Apr. 1, Aug. 15 - Oct. 15	Well-drained to Droughty	Moderate	3
Eastern Bottle-brush Grass	Elymus hystrix		Cold Season	5-10%	Feb. 15 - Apr. 1, Aug. 15 - Oct. 15	Well-drained to Droughty	Moderate	3
Rough Bentgrass	Agrostis scabra		Cold Season	10-20%	Feb. 15 - Apr. 1, Aug. 15 - Oct. 15	Poorly-drained	Poor	2.5
Winter Bentgrass	Agrostis hyemalis		Cold Season	2-5%	Feb. 15 - Apr. 1, Aug. 15 - Oct. 15	Well-drained	Moderate	3.5
Soft Rush	Juncus effusus		Wetland	1-10%	Dec. 1 - May 1, Sep. 1 - Nov. 1	Poorly-drained	Poor	4
Shallow Sedge	Carex lurida		Wetland	1-10%	Dec. 1 - May 1, Sep. 1 - Nov. 1	Poorly-drained	Poor	3
Fox Sedge	Carex vulpinoidea		Wetland	1-10%	Dec. 1 - May 1, Sep. 1 - Nov. 1	Poorly-drained	Poor	3
Leathery Rush	Juncus coriaceus		Wetland	2-5%	Dec. 1 - May 1, Sep. 1 - Nov. 1	Poorly-drained	Poor	2

* Pick at least four species, including one from each type.

Table 6.24d Permanent Seeding Recommendations -- Coastal Plain Region

Common Name	Scientific Name	Cultivars	Type*	Percentage of Mix	Optimal Planting Dates	Soil Drainage Adaptation	Shade Tolerance	Height
Switchgrass	Panicum virgatum	**Blackwell --** well drained **Shelter --** well drained **Kanlow --** poorly drained **Carthage --** well drained	Warm Season	10-15%	Dec. 1 - Apr. 1	Cultivar Dependent	Poor	6
Switchgrass	Panicum virgatum	**Alamo --** poorly-drained	Warm Season	10-15%	Dec. 1 - May 1	Cultivar Dependent	Poor	6
Indiangrass*	Sorghastrum nutans*	**Rumsey, Osage, Cheyenne**	Warm Season	10-30%	Dec. 1 - Apr. 1	Well-drained to Droughty	Poor	6
Indiangrass*	Sorghastrum nutans*	**Lometa**	Warm Season	10-30%	Dec. 1 - May 1	Well-drained to Droughty	Poor	6
Big Bluestem	Andropogon gerardii	**Earl**	Warm Season	10-30%	Dec. 1 - Apr. 1	Well-drained to Droughty	Poor	6
Little Bluestem	Schizachyrium scoparium	**Cimarron**	Warm Season	10-30%	Dec. 1 - Apr. 1	Well-drained to Droughty	Poor	4
Sweet Woodreed	Cinna arundinacea		Warm Season	1-10%	Dec. 1 - Apr. 1	Poorly-drained to Well-drained	Moderate	5
Rice Cutgrass	Leersia oryzoides		Warm Season	5-25%	Dec. 1 - Apr. 1	Poorly-drained	Poor	5
Redtop Panicgrass	Panicum rigidulum		Warm Season	10-20%	Dec. 1 - Apr. 1	Well-drained	Poor	3.5
Beaked Panicgrass	Panicum anceps		Warm Season	10-20%	Dec. 1 - Apr. 1	Poorly--drained	Moderate	3.5
Eastern Gammagrass	Tripsacum datyoides		Warm Season	5-10%	Dec. 1 - Apr. 1	Well-drained to Poorly-drained	Poor	4.5
Purple top	Tridens flavus		Warm Season	5-10%	Dec. 1 - Apr. 1	Well-drained to Droughty	Poor	2.5
Indian Woodoats	Chasmanthium latifolium		Cold Season	1-10%	Feb. 15 - Mar. 20, Sep. 1 - Nov. 1	Well-drained to Droughty	Moderate	4
Virginia Wildrye	Elymus virginicus		Cold Season	5-25%	Feb. 15 - Mar. 20, Sep. 1 - Nov. 1	Well-drained to Droughty	Moderate	3
Rough Bentgrass	Agrostis scabra		Cold Season	10-20%	Feb. 15 - Mar. 20, Sep. 1 - Nov. 1	Poorly-drained	Poor	2.5
Soft Rush	Juncus effusus		Wetland	1-10%	Dec. 1 - Apr. 15	Poorly-drained	Poor	4
Shallow Sedge	Carex lurida		Wetland	1-10%	Dec. 1 - Apr. 15	Poorly-drained	Poor	3
Fox Sedge	Carex vulpinoidea		Wetland	1-10%	Dec. 1 - Apr. 15	Poorly-drained	Poor	3
Leathery Rush	Juncus coriaceus		Wetland	2-5%	Dec. 1 - Apr. 15	Poorly-drained	Poor	2

* Only Lometa in eastern coastal plain (Plant Hardiness Zone 8).

* Pick at least four species, including one from each type.

Maintenance

Many of the recommended permanent grass species may require two years for establishment, depending on site conditions. Inspect seeded areas for failure and make necessary repairs, soil amendments, and reseedings. If weedy exotic species have overtaken the area after the first growing season, the invading species must be eradicated to allow native species to grow. Native vegetations are difficult to manage and take longer to establish. Monitor the site until long term stability has been established.