



VIRGINIA'S FORESTRY BEST MANAGEMENT PRACTICES FOR WATER QUALITY

Field Guide

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Virginia Department of Forestry
www.dof.virginia.gov

**Virginia's Forestry
Best Management Practices
for Water Quality
Field Guide
June 2009**



VIRGINIA'S FORESTRY
**BEST
MANAGEMENT
PRACTICES
FOR WATER QUALITY**

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Table of Contents

Introduction	1
Planning is the Key	3
Planning for Forestry Operations	5
Planning	5
Endangered Species	7
Planning	7
Streamside Management Zones (SMZs).....	12
Planning Tools	15
Logging System Selection.....	16
Logging System Application.....	16
Forest Roads	23
Road Alignment and Location	24
Road Drainage	26
Constructing Forest Roads.....	31
Excavation	31
Construction.....	32
Soil Protection	34
Designing Wetland Forest Roads.....	35
Constructing Wetland Forest Roads.....	37
Skid Trails	39
Stream Crossings	43
Locating Stream Crossings	43
Stream Crossing Design	44
Bridges	45
Pole Bridges	47
Culverts	49
Fords	55

Table of Contents

Log Landings	57
Log Landing Construction.....	58
Landing Maintenance	60
Post-Harvest Closure	61
Erosion Control Measures	65
Wing (Lead-Off) Ditches	65
Brush Barrier.....	67
Silt Fence.....	68
Straw Bale Barrier.....	69
Rock Check Dams.....	70
Temporary Fill Diversion	71
Temporary Slope Drain.....	72
Level Spreader	73
Revegetation	75
Specifications for Revegetation	75
Main Crop	77
Legume	78
Grains and Grasses	79
Critical Planting Area.....	80
Regulations	81
Federal Clean Water Act–Mandated Road BMPs for Wetlands	81
Silvicultural Operations in Chesapeake Bay	
Preservation Areas.....	83
Silvicultural Water Quality Law.....	83
Debris in Streams Law	84
Agency Listing	87

Introduction



Protecting water quality and the forest and soil resources on the land are among the most important aspects of a successful and environmentally sustainable timber harvest. Studies have shown that while timber harvesting is not a major cause of water quality problems, skid trails, haul roads and landings have the potential to be sources of sedimentation, erosion and siltation of streams and other water bodies. Forest management programs and operations should incorporate

Introduction

adequate measures to provide for proper soil and water conservation. Most streams originating in or flowing through our timberlands are sources for water supplies, recreation and a wealth of other uses.

The key to success is proper planning and the use of forestry best management practices (BMPs). These are practices chosen to reduce erosion and prevent or control pollution resulting from forestry operations. Forestry BMPs are directed primarily at controlling erosion.

This field guide is intended to be a practical tool for timber harvesters, forest managers and landowners. It presents suggestions, guidelines and technical references on a range of timber harvesting BMPs.

The guide is not meant to replace on-the-ground recommendations by a qualified professional forester or resource professional and should not be used as a substitute.

The ultimate goal is to have an economically viable timber harvest that protects the soil, water and other forest resources from loss or degradation. BMPs can help attain this goal. *Alternative methods that achieve equal water quality protection are acceptable.*

Introduction

Non-point source pollution is generated from land runoff resulting from precipitation. As the runoff moves over the land surface, it picks up and carries away natural and manmade pollutants and deposits them into waterways, wetlands and groundwater, damaging fish habitats and spawning areas, and making the water unsuitable for other uses downstream.

Planning is the Key

It is almost always more economical to plan timber harvesting activities in advance and to take preventive measures than it is to try to "fix" problems after they occur. It is intended that the suggestions outlined in this field guide, if followed, will minimize the impact from timber harvesting on the waters of the Commonwealth and will provide a viable forest resource for the future of all Virginians.

Introduction

Planning for Forestry Operations

Planning

Timber harvesting activities should follow a well-designed plan with the ultimate outcome being an efficient operation that provides protection of soil and water resources. A forestry professional should be consulted for planning assistance.

Planning should help identify sensitive areas and applicable BMPs to be used during the silvicultural activity. A variety of tools can help in the evaluation of the property and the development of the plan. These tools include aerial photographs, soil survey maps, topographic maps, property or survey maps and timber stand maps.

A field reconnaissance to identify areas of special concern, such as streams, ponds, lakes, wetland sites, boundary restrictions, rock outcrops and nesting sites, should always be conducted to ensure an efficient operation.

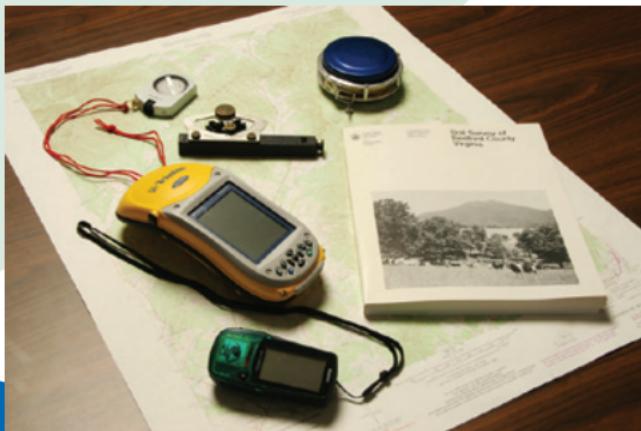
Planning not only considers how the timber will be accessed, but also when the timber will be cut. Timing of harvest is one of the more important BMPs.

Failing to Plan is Planning to Fail

Planning for Forestry Operations

The benefits of a well-developed plan and/or written contract include:

- ◆ better communication of expectations between the landowner and timber operator
- ◆ maximum return from the harvest
- ◆ potential long-term benefits in site productivity
- ◆ better infrastructure
- ◆ economic efficiency
- ◆ minimal environmental impacts
- ◆ compliance with federal, state and local laws
- ◆ enhancement of habitat for wildlife diversity



Planning for Forestry Operations

Endangered Species

If you suspect the presence of an endangered species on the property where the forestry activity is to occur, contact one of the following:

- ◆ Virginia Department of Game and Inland Fisheries
- ◆ Virginia Department of Conservation and Recreation, Division of Natural Heritage
- ◆ U.S. Fish and Wildlife Service

These agencies should be able to assist with verification and management considerations. A listing of these agencies can be found in the back of this field guide.

Planning

Once a site evaluation has been conducted, follow these recommendations to plan forest harvesting activities:

Notify the Virginia Department of Forestry on-line or by calling the toll-free logging notification number:

**www.dof.virginia.gov
1-800-939-LOGS (1-800-939-5647)**

*This is a requirement of the law.
Violators will be subject to a civil penalty
for failure to notify.*

Planning for Forestry Operations



- ◆ Things to note in the site evaluation:
 - Slope, aspect, soils, timber, streams, wetlands, access, boundaries, old roads and indicator plants.
 - Become familiar with all of the tract characteristics that will impact logging.
- ◆ Identify and mark on the ground the Streamside Management Zones (SMZs) on all perennial and intermittent streams as indicated on a USGS topographic map.
- ◆ Locate and flag logging decks (landings). These should be on stable soils with a slight sloping for drainage.

Planning for Forestry Operations

- Locate and mark any logging road stream crossings, if necessary. Avoid them if possible, and if they are necessary, consideration should be given to the type of crossing to be used.
- Locate and mark logging road entrance points from public roads, providing for good traffic visibility in all directions at the entrance.



Planning for Forestry Operations

- ◆ Locate any other logging road “control” points. These are points at which the logging road must either connect or avoid. Examples: entrance points, stream crossing points, rock outcrops and wetland areas.
- ◆ Locate and flag the logging road gradeline (in the mountains) or centerline (coastal plain). Ideally, the gradeline should be kept at 10 percent or less. Try to locate the haul road on well-drained, stable soils with good load-bearing capacity, such as clay or sandy-clay loams with a solid base.
- ◆ Locate and flag designated skid trails, if necessary.
- ◆ Specify stream-crossing structures and period of time required of the crossing:
 - Ford
 - Modified Geoweb® improved ford
 - Culvert
 - Bridge
- ◆ Determine the schedule of operations and the harvest pattern. Some of the factors involved in this decision will be tract topography, time of year, anticipated weather conditions, road construction requirements, cash flow and marketing allowances (generally determined by the mill).

Planning for Forestry Operations

- ◆ Specify tract “close-down” requirements. These generally involve implementation of BMPs to minimize erosion and stream sedimentation on the site after harvesting is completed. They include:
 - Re-grading ruts
 - Installing water bars on roads and skid trails
 - Reseeding landings and roads
 - Removing any temporary stream crossing structures
 - Scattering brush
 - Opening ditches and turnouts
- ◆ Close and gate the road to unauthorized traffic.
- ◆ Determine the need for permits and obtain them, if necessary. Check with the local field office of the Virginia Department of Forestry for other agency permit requirements.



Planning for Forestry Operations

Streamside Management Zones (SMZs)

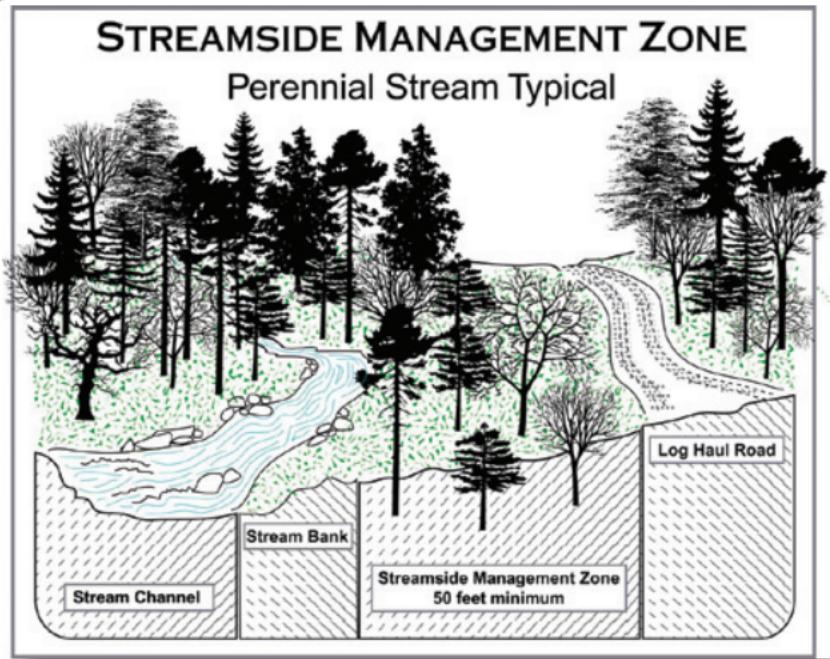
Streamside Management Zones are areas adjacent to streams that protect water quality. An effective SMZ will filter sediment and nutrients, maintain desirable water temperature, and provide many of the essential requirements of forest stream ecosystems.



**In Tidewater Virginia,
all Forestry BMPs must be
implemented properly according to
the Chesapeake Bay Preservation Act.
The SMZ is one such BMP and must
be left according to specifications in
this section, or it will be considered a
violation of this Act.**

SMZs should be left on perennial and intermittent streams, as well as lakes, ponds, natural springs, municipal water supplies, and in areas of karst geology where flowing streams enter caves.

Planning for Forestry Operations



A 1:24,000 USGS topographic map is a good starting point for identifying major perennial and intermittent streams. Perennial streams are identified as a solid blue line, and intermittent streams are shown as a dotted blue line. It must be remembered that many intermittent streams that do not show up on a topographic map may merit an SMZ. Identifying characteristics of an intermittent stream include a defined stream channel,

Planning for Forestry Operations

evidence of streambed scouring, and bare soil or rock showing on the bottom of the streambed.

It is recommended that all SMZs be a minimum of 50 feet in width, measured from the top of the stream bank. This 50-foot SMZ is a managed forest; within this managed area, up to 50 percent of the basal area or up to 50 percent of the forest canopy can be harvested.

In areas adjacent to tidal marshes, the SMZ will begin at the marsh grass/forest edge and 50 feet inland.

- Harvesting within the SMZ should minimize disturbance. The forest floor should remain virtually undisturbed.
- Manual felling, directional felling and mechanized felling can be effectively used provided minimal disturbance of the forest floor results.
- Water bars, broad-based dips and culverts should be used on skid trails and haul roads prior to entrance into the SMZ.
- All roads, trails, decks and sawmill sites should be located outside of the SMZ where possible. If necessary, additional practices may be required to protect water quality.
- Steep slopes, cold-water fisheries and municipal water supplies all need wider SMZs to protect water quality.

Planning for Forestry Operations

The following table lists those widths:

Table 1
Streamside Management Zone (SMZ) Width

Percent Slope of Adjacent Lands (%)	SMZ Width Per Side (ft.)		
	Warm Water Fisheries (all other waters including wetlands)	Cold Water Fisheries (Trout)	Municipal Water Supplies (Streams or Lakes)
0 - 10	50	66	100
11 - 20	50	75	150
21 - 45	50	100	150
46 +	50	125	200

Planning Tools

- ◆ Aerial Photographs
- ◆ County Soil Survey Maps
- ◆ USGS Topographic Maps
- ◆ Wetland Inventory Maps
- ◆ Natural Heritage database maps (for T & E species)

Planning for Forestry Operations

Logging System Selection

A logging system is the combination of equipment and personnel used to harvest timber. Matching the right harvesting system to the specific harvesting conditions can result in minimizing the impact to the harvest site. Effective BMP implementation to mitigate harvesting impacts is dependent on the proper logging system application. Application of the proper logging system to the specific site will also result in higher productivity and lower harvesting costs.

Logging System Application

- *Animal* – Animals are best used to skid timber on flat terrain close to existing roads. The system is limited by the weight of the animals and their ability to pull and, in general, can be used to move up to 20-inch-diameter timber on favorable slopes.
- *Tracks* – Track machines are best used where short, steeper slopes prohibit overland rubber-tired skidding. Yarding distance is limited and these machines generally can be used on slightly wetter sites.

Planning for Forestry Operations



- ❖ *Skidder* – Rubber-tired skidders have application in the broadest range of logging conditions in Virginia. Skidders are a flat ground system but, with winches, can be effectively used on flat to moderate slopes. This skidding system has limitations when:
 - Weather conditions are unfavorable
 - Skidding distances exceed 1,500 feet due to the cost of road construction
 - Steep Slopes

Planning for Forestry Operations



- *Shovel* – Shovel logging is limited to clear cutting when it is necessary to pick up and swing the timber toward the road. Shovels can work in adverse weather, in wet areas and on steep slopes.

Planning for Forestry Operations



- *Forwarder* – Forwarders are best applied where longer yarding distances in fairly gentle terrain are needed to avoid expensive truck road construction.
- *Cable* – Cable logging systems are best applied where excessive slope would require ground-based systems to build an excessive number of excavated skid trails.
 - Requires excessive slopes to operate efficiently
 - Yarding distances of up to 1,500 feet are not uncommon
 - Can operate under adverse weather conditions

Planning for Forestry Operations

- *Helicopter* – Best applied when road costs are high; large volumes must be moved in a short period of time; sawtimber only is planned for the harvest; the ability to harvest in adverse weather is needed, or when the landowner's objective is to minimize the environmental impacts of harvesting. Maximum yarding distance is 6,000 feet.



Planning for Forestry Operations

Effective BMP implementation for timber harvesting operations needs to consider appropriate logging system selection and harvest planning. Use of the proper logging system for the specific logging conditions can result in lower costs and lower environmental impacts.

Proper planning, from the location of the roads and decks to the type of logging system used, is essential to reducing the impact of the operation on the property.



Planning for Forestry Operations

Forest Roads

Proper road construction will minimize disturbance to waterflow over the landscape and ensure the longevity and stability of the road. Forest roads provide a simple road structure of adequate strength to support heavy vehicle traffic while providing adequate drainage to allow water to pass through the road corridor.



BMPs for forest roads are designed to provide greater opportunities for safe, efficient and profitable operations. A well-planned and properly-constructed forest road is necessary to effectively protect the forest land and water quality when removing forest products from the harvest site.

Forest Roads

Site characteristics and the value of the resource being served will influence choices regarding road construction standards and maintenance activities. Culverts and ditches may be necessary in many situations.

Well-drained and properly surfaced forest roads prevent erosion and provide better wet weather harvesting access. This will, in-turn, provide more operating days for the logging contractor.

Road Alignment and Location

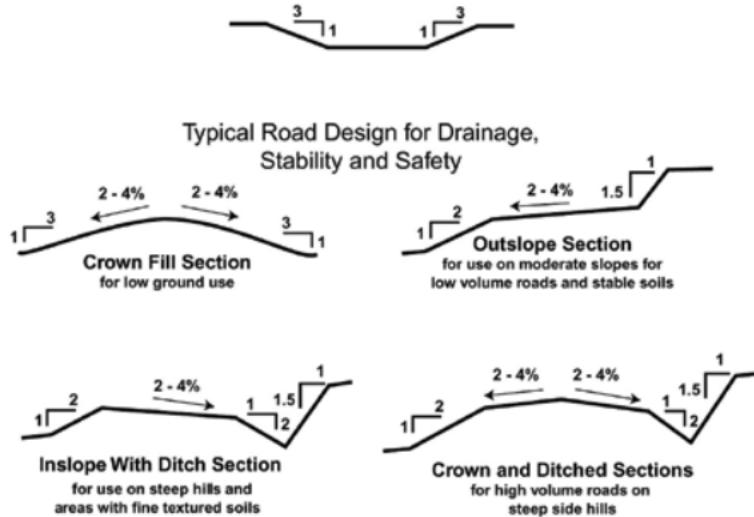
The proper alignment and location of roads will reduce the potential for non-point source pollution. The following recommendations should be incorporated in the road design:

- Roads should follow contour as much as possible with grades between two percent and 10 percent. Steeper gradients may be necessary due to boundary lines or SMZ restrictions; in these cases, additional BMP measures may be required.
- Forest roads should be out-sloped wherever road gradient and soil type will permit.
- Use in-sloping or ditch-and-culvert type of cross-section when constructing a road where road gradients exceed 15

Forest Roads

percent, toward sharp turns, or when constructed on clay and/or slippery soils. Cross-drainage culverts should be incorporated in this instance.

TRUCK HAUL ROADS



Forest Roads

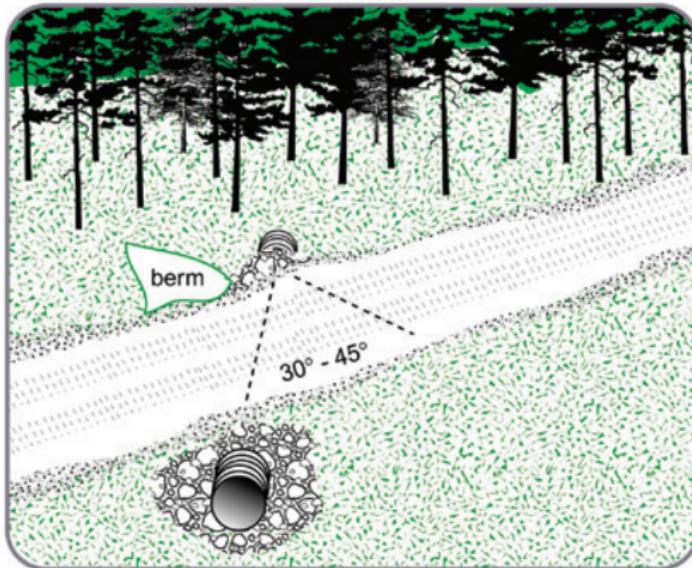
Road Drainage

Water flowing along or onto the road should be diverted before gaining sufficient volume or velocity to cause significant erosion of the road and ditch. The following recommendations should be used to minimize erosion:

- Control the flow of surface water on roads by using a combination of the appropriate road cross-section and water diversion structures within the roadbed itself.
- Install cross drains and diversion ditches to avoid carrying water long distances in roadside ditches.
- Road cross drains may include pipe culverts, rolling dips or broad-based dips.
- A 15-inch pipe culvert is the minimum recommended size for cross drainage. Smaller culverts can clog with debris and require frequent maintenance.
- Spacing for cross drainage is critical as slope increases. (See table on page 28.)
- Size stream-crossing culverts and other drainage structures large enough to minimize impact on water flow and water quality. For more details, see *Stream Crossing Section* starting on page 43.

Forest Roads

CROSS-DITCH CULVERT



Forest Roads

Table 2
Suggested Spacing for
Cross-Drainage Culverts

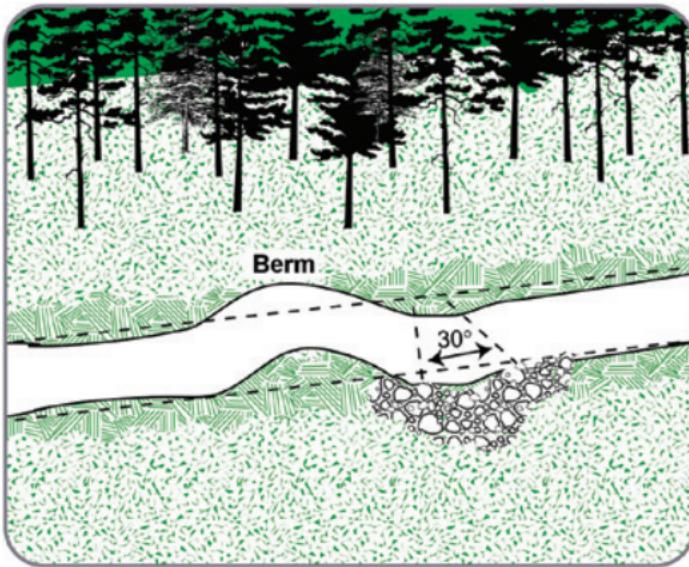
Cross-Drainage Road Grade (%)	Culvert Spacing Distance (ft.)
0 - 2	500 - 300
3 - 4	250 - 180
6 - 10	167 - 140
11 - 15	140 - 136
16 - 20	126 - 120
21 +	100

Table 3
Suggested Spacing for Rolling Dips

Road Grade (%)	Distance (ft.)
2 - 5	180
5 - 10	150
10 - 15	135
15 +	120

Forest Roads

BROAD-BASED DIP



- Avoid draining surface water from roads and ditches directly into streams, ponds, lakes or wetlands. Instead, drain the water into the filter strip or other vegetated area.
- Build a sediment trap into the ditch to catch debris as it travels down the ditch.

Forest Roads

Table 4
Suggested Spacing
for Broad-Based Dips

Road Grade (%)	Distance (ft.)
2	300
3	235
4	200
5	180
6	165
7	155
8	150
9	145
10	140
12	135

Forest Roads

Constructing Forest Roads

Proper construction of roads is a vital step in preventing erosion. The following are some practices that may lessen the potential for problems to develop.

Clearing widths will vary depending on the needs of both the owner and the user of the road. Consideration should be given to the necessity for roadway drying and to safety and cost of various widths of road right-of-ways.

Excavation

- ◆ Minimize cuts and fills as much as possible during design and construction.
- ◆ Tall cut slopes may require back-sloping to achieve stability and successful revegetation. Slopes of 1:1 or flatter are preferred if the terrain permits.
- ◆ Do not side cast material if there is a chance it will enter a stream channel or if side slope exceeds 60 percent. (Full bench construction with removal of fill material offsite may be necessary in this situation.)
- ◆ Locate access roads outside of SMZ unless no other alternative exists.

Forest Roads

- Deposit excess material in stable locations away from streams, ponds, lakes and wetlands.
- Avoid placing excavated material in SMZs.
- Limit the area excavated to that which can be shaped and stabilized within a day, with provisions made for storm drainage and sedimentation control.

Construction

Site drainage and cross-drainage are important for controlling sedimentation. Proper handling of water during construction will minimize potential impacts on water quality. These recommendations should be followed to reduce possible impacts:



- Provide adequate drainage for road grades during construction to minimize erosion of unconsolidated materials.
- Install drainage structures as construction proceeds.

Forest Roads

- Avoid locating roads with grades in excess of 10 percent. On highly erodible soils, also identified on soil survey maps, a grade of less than eight percent is recommended.
- Minimize down-road flow and ponding by constructing roads with a slight outsloping of one or two percent. Install broad-based dips or rolling dips if grades are greater.



- Crown the road surface and excavate ditches where necessary.
- Compact fill firmly around culverts, paying special attention to the sides and lower portion. Cover the top of the culverts with fill to a depth of one-half the pipe diameter or 12 inches, whichever is greater.
- Use riprap or large boulders to stabilize culvert inlets and outlets to reduce bank and channel erosion and sedimentation.

Forest Roads

- Provide temporary cross-drainage structures, such as water bars, during construction where needed to drain water off road surfaces.
- Install siltation barriers, such as silt fences and straw bales, during construction on sites where roads and water have close contact for long periods.

Soil Protection

Disturbed areas should be shaped, stabilized and, if necessary, seeded as soon as possible to minimize the potential for erosion. The greatest potential for soil erosion occurs immediately after construction.



Forest Roads

The following measures are recommended:

- ◆ Vegetative cover is recommended along all forest roads. To prevent erosion before vegetation takes hold, mulch with hay, straw, bark or native vegetation. Hay or straw mulch should be applied at the approximate rate of 80 bales per acre.
- ◆ Inspect and repair erosion control measures on a regular basis to ensure that they remain functional.

Designing Wetland Forest Roads

Timber operators are strongly advised to use the services of a professional forester to design wetland forest roads. This professional assistance is particularly important when constructing permanent all-season roads.

The following general recommendations apply when planning the design of all roads across wetlands:

- ◆ Avoid crossing wetlands if possible.
- ◆ Minimize total wetland road mileage when wetlands must be crossed.
- ◆ Determine the type and depth of wetland subsoil to ensure proper design and construction.

Forest Roads

- Minimize width of roads consistent with maintaining safety and road design considerations. This typically would be a running surface of 12 feet in width for straight sections, and the curved road running surface would be no wider than 16 feet.
- Design approaches to wetlands so that surface runoff carrying potential sediment is diverted before entering the wetland.
- Plan to remove temporary fills and structures to the extent practical when use is complete.
- Provide adequate cross-drainage by employing one or both of the following techniques:
 - Use construction methods that allow free water flow throughout the entire roadbed, or
 - Place 24-inch culverts or other cross-drain structures at regular intervals across the fill material throughout the wetland road. These culverts should have one-half their diameter placed below ground level to handle sub-surface flow.

Forest Roads

Constructing Wetland Forest Roads

Choosing the appropriate road construction technique will depend on knowledge of water table position, zone of water flow, type of wetland soils and the strength of wetland soils.

With any road construction technique, culverts or ditches (or both) may be necessary.

Follow these recommendations when constructing ditches on wetland roads:

- ◆ Construct all road embankments with clean fill and other suitable materials.
- ◆ Construct ditches in wetland crossings, where necessary, to intercept and carry surface and subsurface water (the top 12 inches) to, through and away from culverts.
- ◆ Avoid having ditches create outlets that will result in drainage of the wetland.

Employ sediment control techniques, such as straw bales and silt fencing, to prevent movement to open water when placing fill during construction.

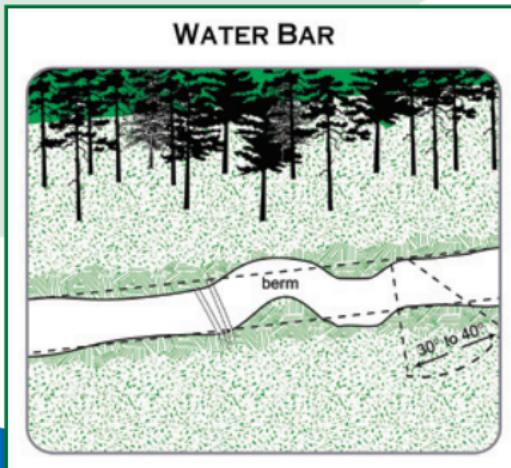
Forest Roads

Skid Trails

- Use existing trails if they provide the best long-term access. Consider relocating existing trails if both access and environmental impact can be improved.
- Consider the topography in the location of skid trails and avoid steep slopes whenever possible.
- Where possible, keep bladed or dozed skid trail grades to less than 25 percent. Where steep grades are unavoidable, frequent grade breaks are recommended. Install drainage structures and use soil stabilization practices where needed to minimize runoff and erosion.
- Overland or dispersed skidding on steep slopes should not exceed 35 percent or when bare soil areas provide potential for channelized flow.
- Skid trails should be located outside the SMZ.
- Any skid trail that must cross a perennial stream, intermittent stream or drainage ditch should use a bridge or culvert of acceptable design (see Stream Crossing Section). *Logs shall not be dragged through an intermittent or perennial stream at any time.*

Skid Trails

- Lay out skid trails to use low-value trees as “bumper trees” at turns to reduce residual tree damage.
- Install water turnouts 25 feet prior to a stream crossing to direct surface runoff into undisturbed areas of the SMZ.
- A brush mat of logging slash can be used to stabilize skid trails on stream crossing approaches. This alleviates rutting and firms up the running surface.
- Rutting should be avoided whenever possible and especially where it causes channelized erosion. If rutting is unavoidable, concentrated skidding may be used to reduce the amount of disturbance, *but in no instance may channelized erosion be allowed to direct sediment into a stream channel.*



Skid Trails

- Upon completion of skidding activity, water bars should be installed immediately in areas subject to erosion.

Table 5
Water Bar Spacing

Road Grade (%)	Distance Between Water Bars (ft.)
2	250
5	135
10	80
15	60
20	45
30	35

Skid Trails

- Watch the weather forecast and plan ahead for severe storms.
- All woods roads and skid trails should be repaired, smoothed and seeded after logging, and be left in a stable condition to resist erosion.



Stream Crossings

Stream Crossings

Stream-crossing structures are installed across intermittent or perennial streams to provide access for logging equipment. When properly located and constructed, stream-crossing structures can prevent damage to the bed and banks of streams and can control the movement of sediment into the water.

Stream-crossing structures that are poorly located or constructed can result in disturbance of the banks and bottoms of streams, increasing the chance for erosion and sedimentation to occur.

A forestry professional or Department of Forestry forest engineer can assist in planning the stream-crossing structure best suited to the site.

Locating Stream Crossings

- ◆ Use stream crossings only when absolutely necessary.
- ◆ Keep the number of stream crossings to a minimum.
- ◆ Cross streams by the most direct route and at a right angle to the flow of the stream, if possible.

Stream Crossings

- Whenever possible, find stream-crossing sites that have low, stable banks, a firm stream bottom, minimal surface runoff and gentle slopes along the approaches.
- Stabilize the soil around all culverts and bridges immediately after installation.

A permit is required from the Virginia Marine Resources Commission for all stream-crossing structures that cross a stream that has a drainage area of greater than five square miles or 3,200 acres.



Stream-Crossing Design

Operating equipment in or near perennial or intermittent stream channels may add sediment directly to streams.

As roads approach a stream crossing, proper road drainage is critical to avoiding sedimentation in streams. Three common stream-crossing structures are bridges, culverts and fords.

Stream Crossings

Bridges

Bridges are the preferred method of crossing streams because they require little or no in-stream work to install. They typically require less time to install and can be used many times, thus making them more cost-effective than culverts. Because they cause little disturbance to the stream banks or channel, they also have less effect on fisheries than any other crossing method.

Any bridge installed for use by the general public for public transport should be designed by a licensed civil engineer.



Stream Crossings

Bridge Installation

- ◆ Temporary bridges should be installed at right angles to the stream.
- ◆ Bridges should be of sufficient length to maintain at least five feet of bridge/ground contact on each side of the stream (this will vary by bridge design).
- ◆ Mud sills consisting of rough sawn hardwood beams 16 inches wide, three inches thick and 16 feet long can be used to provide additional load bearing capacity in soft soils.
- ◆ Approaches should be stabilized with rock, corduroy, brush or other non-erodible surface for a distance of 50 feet on either side of the bridge.
- ◆ Prompt stabilization after removal of the bridge will be most critical to the protection of stream water quality.



Stream Crossings

Pole Bridges

Pole bridges may be used when crossing a stream channel where no water is present. Pole bridges are constructed by laying wooden logs of no less than 10 inches in diameter in a stream channel, creating a solid foundation on which to skid. This structure may incorporate the use of heavy gauge steel pipe with the logs to allow for short periods of flow should it rain.

Pole bridges should not be used on channels greater in width or depth than the diameter of a skidder tire.

Pole bridges can be used in dry, intermittent stream channels for a short period of time.

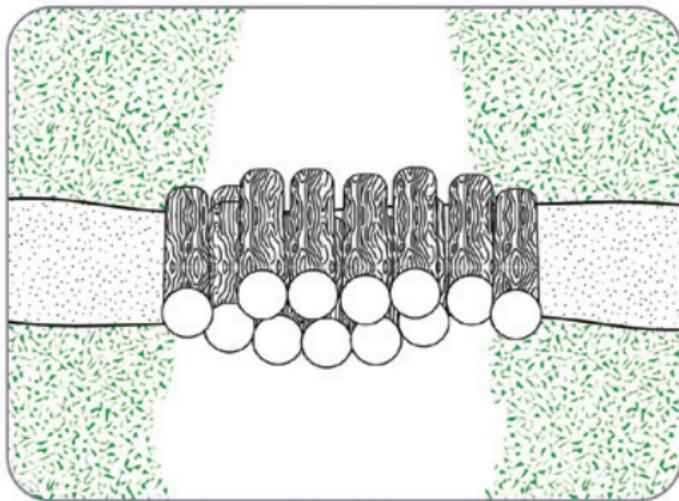
Pole Bridge Installation

- ◆ Pole bridges should be packed sufficiently so as not to allow the skidder to dip below the streambank edge and cause erosion of the bank.
- ◆ A heavy-gauge steel pipe incorporated in the structure will help in the event of an unforeseen rainfall event while the structure is in place.
- ◆ Pole bridges should not have any dirt associated with the logs.

Stream Crossings

- Pole bridges must be removed following use of the crossing.
- Stabilize the approaches with the appropriate water diversion structures and vegetation following removal of the structure.

POLE BRIDGE



Stream Crossings

Culverts

Culverts may be either temporary or permanent installations. Temporary culverts are those that are installed and used for fewer than 30 consecutive months.

Permanent culverts are those remaining after the logging operation at the request of the timber buyer or landowner. (Proper permitting may be required for this situation. Check with the VDOF forest engineer prior to installation of a permanent culvert.)

Most culvert installations for harvesting purposes are considered to be temporary and must be removed. A reduced-sized culvert is permitted for temporary installations.

Temporary Culvert Chart

The table on the next page lists culvert diameters for temporary culvert sizes. *This chart is intended to be used as a guide. No guarantees are given nor are any implied by its use.*

Stream Crossings

**Table 6
Temporary Culvert Sizing (2-Year Event)**

Culvert Size (in.)	Watershed (acres)		
	Coastal	Piedmont	Mountains
15	Up to 65	Up to 35	Up to 15
18	65 - 90	35 - 65	15 - 25
24	90 - 200	65 - 110	25 - 40
30	200 - 400	110 - 210	40 - 60
36	400 - 700	210 - 420	60 - 135
42	-	-	135 - 230

- Based on the NRCS TR-55 Method modified for a two-year frequency storm event.
- Assumes B soils; a CN-55, and sheet and shallow concentrated flows only for averages of four watersheds for each physiographic region of the state.
- Culvert-crossing solutions for watersheds greater than 600 acres should be designed based on the specific situation.

Stream Crossings

Permanent Culvert Chart

Table 7 lists culvert diameters for permanent culvert sizes. *This chart is intended to be used as a guide. No guarantees are given nor are any implied by its use.*

Table information based on the NRCS TR-55 Method, modified for a 10-year frequency storm event. All assumptions are the same as the temporary chart.

Stream Crossings

Table 7
Permanent Culvert Sizing (10-Year Event)

Culvert Size (in.)	Watershed (acres)		
	Coastal	Piedmont	Mountains
15	Up to 8	Up to 7	Up to 4
18	8 - 12	7 - 10	4 - 7
24	12 - 25	10 - 20	7 - 12
30	25 - 35	20 - 30	12 - 15
36	35 - 70	30 - 50	15 - 25
42	70 - 100	50 - 75	25 - 35
48	100 - 150	75 - 110	35 - 55
54	150 - 240	110 - 170	55 - 75
60	240 - 360	170 - 240	75 - 100
66	360 - 550	240 - 350	100 - 135
72	-	-	135 - 200

Stream Crossings

If it is preferable to place multiple smaller culverts instead of one large one, the following table shows the required diameters of multiple pipes to replace one larger one.

Table 8 Culvert Alternatives (diameter in inches)		
Required Culvert Diameter (in.)	2-Culvert Alternative	3-Culvert Alternative
15	—	—
18	15, 15	—
24	15, 18	15, 15, 15
30	18, 24	18, 18, 18
36	24, 30	18, 24, 24
42	30, 30	24, 24, 30
48	36, 36	30, 30, 30
54	36, 42	30, 36, 36
60	42, 48	36, 36, 42
66	42, 54	42, 42, 42
72	48, 60	48, 48, 48
84	60, 66	48, 54, 54

Stream Crossings

Culvert Installation

- ◆ The pipe length will extend one foot beyond the edge of the fill material on each side of the culvert.
- ◆ The culvert should be placed on the same grade as the natural stream bottom.
- ◆ Culverts should be installed with 10 percent of its diameter below the streambed. This will minimize undercutting at the inlet or outlet. If the outlet is more than six inches above the natural stream channel, an energy absorbing structure should be placed at the outlet.
- ◆ Culverts require periodic maintenance and inspection to avoid blockage.
- ◆ Culvert pipes less than 15 inches in diameter are not recommended for stream crossings.



Stream Crossings

Fords

Natural rock fords are an acceptable crossing method in portions of the piedmont and mountain areas. They may also prove useful with improvements to portions of the coastal plain. In certain situations, they may be the most acceptable of the stream crossing types because of the reduced amount of continued stream disturbance.



Stream Crossings



Any changes made to stream bottoms – including the addition of foreign material or unnatural material into a stream that has a drainage area in excess of five square miles – require a permit from the Virginia Marine Resources Commission.

Construction of a Ford

- Locate fords where stream banks are low.
- The stream should have a firm rock or gravel base; otherwise, install stabilizing material, such as reinforced concrete planks, rubber or wooden mats or Geoweb®, for improvement of streambed stabilization.

Log Landings

Log Landings

Landings are one of the most visible parts of any timber harvest. If possible, locate the landing out of sight of the public. Log landings are the areas where logs are concentrated, processed, sorted and loaded prior to shipping. Care should be taken to locate the landing in an area that is well-drained to reduce the chance for erosion or sedimentation. Landings are subject to severe compaction. Additional effort may be required to establish a vegetative cover on these compacted areas.



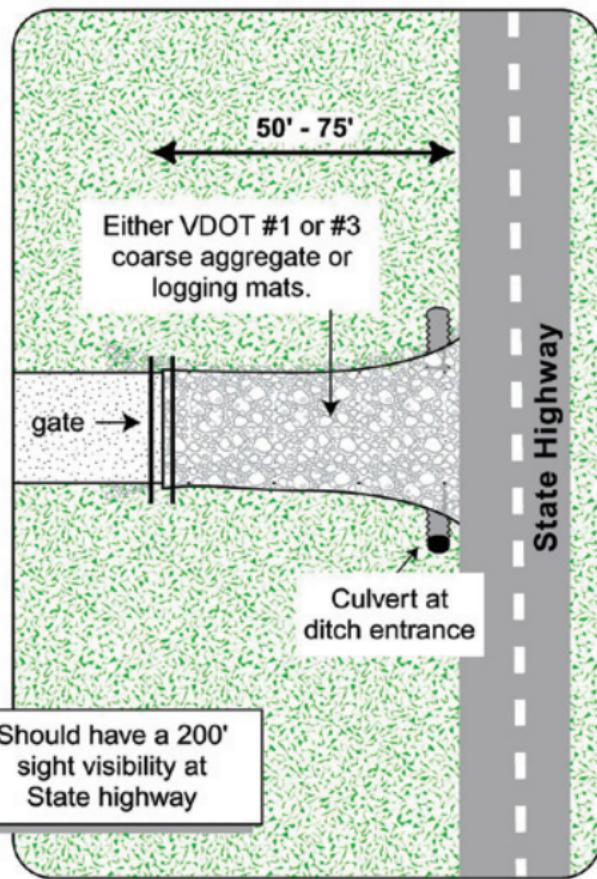
Log Landings

Log-Landing Construction

The following recommendations should be considered when planning, locating and constructing landings and roads to and from the landings:

- ◆ Use existing landings if possible. Close existing landings next to streams and water bodies unless construction of new landings would cause greater harm to water quality than using existing landings.
- ◆ Log landings should be located at least 50 feet from the Streamside Management Zone. If closer placement is necessary, additional BMP measures should be considered (such as straw bales or silt fence).
- ◆ Locate landings on firm, well-drained soil that is slightly out-sloped to promote efficient drainage.
- ◆ Size all landings to the minimum necessary for the acreage to be harvested, yet with enough room for efficient equipment operation and product sorting and removal.
- ◆ Locate residue piles, such as slash, sawdust and chips, away from drainages where runoff may wash residue into streams, lakes or wetlands.
- ◆ Locate diversions, such as water bars, on skid trails leading into the landing. Construct skid trails to prevent water from flowing into the landing and ponding, where

Log Landings



Log Landings

compaction from the machinery has occurred.

- ◆ Locate diversions, such as water bars and broad-based dips, on the truck haul road leading out from the landing to prevent water and sediment from flowing out onto the public highway.
- ◆ Place coarse rock or stone to shake mud off vehicles before entering public highways.
- ◆ Remove all mud tracked onto public roads immediately.
- ◆ During muddy conditions, use coarse rock over geotextile to keep the rock in place.

Landing Maintenance

- ◆ Check fittings and hoses regularly to prevent leaks of lubricants and hydraulic oil. Repair all leaks immediately.
- ◆ Have oil-absorbent mats or material on landing in the event of fuel oil, hydraulic fluid or lubricant spills.
- ◆ Remove all unnatural debris, such as cans, paper, discarded tires, cables and chains, etc., on a daily basis.
- ◆ Scatter all woody debris to improve drainage and appearance of the site.
- ◆ If necessary, soil should be stabilized by seeding and mulching at the end of the operation.

Post-Harvest Closure



The “close-down” of the timber harvest operation is one of the most important considerations to the protection of water quality. The installation of the appropriate BMPs at this time will minimize erosion and stream sedimentation following the timber harvest. If the harvest has been effectively planned, the requirements for “close-down” will be minimal. The necessary BMPs should be installed throughout the operation as various portions of the site are harvested.

Post-Harvest Closure

Upon completion of the harvest operation:

- ◆ All road surfaces should be crowned, outsloped, insloped or water-barred. Remove berms from the outside edge of the road or trail where water can be channeled.
- ◆ Abandoned roads should be left in a condition that provides adequate drainage without further maintenance.
- ◆ Do not allow closed roads to become stream channels. Divert channelized flow of water off the road surface.



- ◆ Temporary bridges, abutments, culvert pipes or other crossing structures should be removed prior to road closure. All stream channels should be restored to their natural condition.

Post-Harvest Closure

- ◆ Cut and fill slopes should be reshaped to a stable gradient and vegetation established on all bare soil areas with a slope greater than five percent.
- ◆ All unnatural debris, such as cans, paper, discarded tires and metal parts, etc., must be removed from landings.
- ◆ Exposed soils prone to erosion should be seeded and mulched at the end of the operation.
- ◆ Fill in ruts and install water bars and erosion barriers to prevent or minimize erosion and sedimentation from roads, skid trails and landings.
- ◆ Inspect erosion control measures periodically and maintain or remove as needed.

Traffic barriers should be placed where appropriate to prevent off-road vehicles from disturbing the recently stabilized areas. Barriers should be visible and well marked, and should not present a safety hazard.

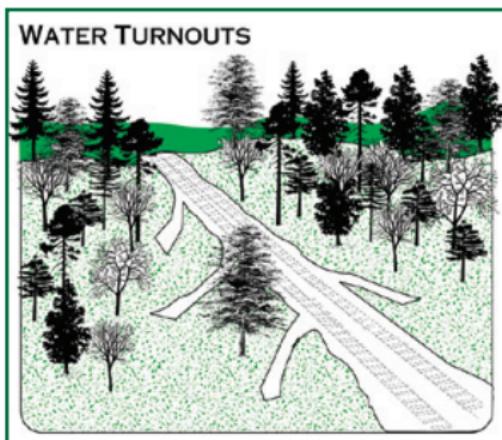
Post-Harvest Closure



Erosion Control Measures

Wing (Lead-Off) Ditches

A lead-off ditch is a diversion ditch that is constructed to turn water away from the road and out of the side ditch into adjacent, undisturbed areas.



Lead-off ditches should:

- ◆ Intersect the roadside ditch at the same depth and be outsloped to a maximum grade of two percent.
- ◆ Not feed directly into adjacent drainages, gullies or channels.

Erosion Control Measures

- Be installed or cut solidly into the soil and wide enough to allow for maintenance.

Table 9
Maximum Distance Between
Lead-Off Ditches

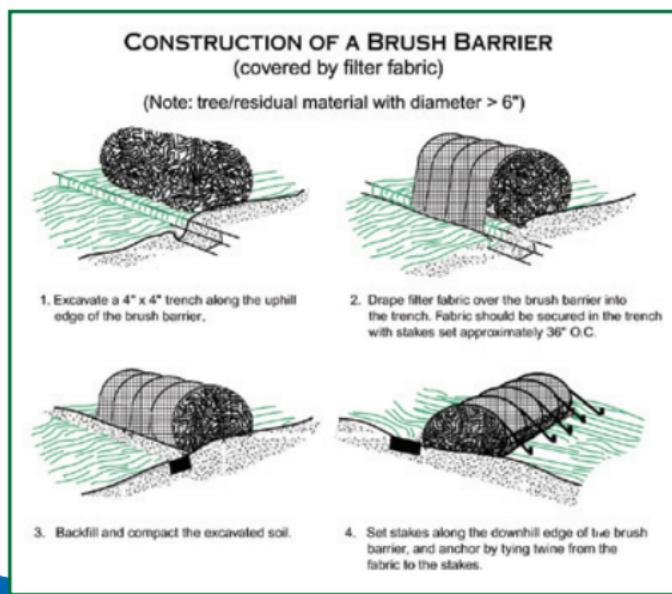
Slope	Slope (%)	Distance (ft.)
Flat	2	250
	3	220
	4	190
	5	160
Moderate	6	144
	7	128
	8	112
	9	96
Steep	10	80
	11	60

Erosion Control Measures

On sloping roads, the lead-off ditch should leave the road ditch at a 30 to 45 degree angle to the roadbed and downsloped less than two percent.

Brush Barrier

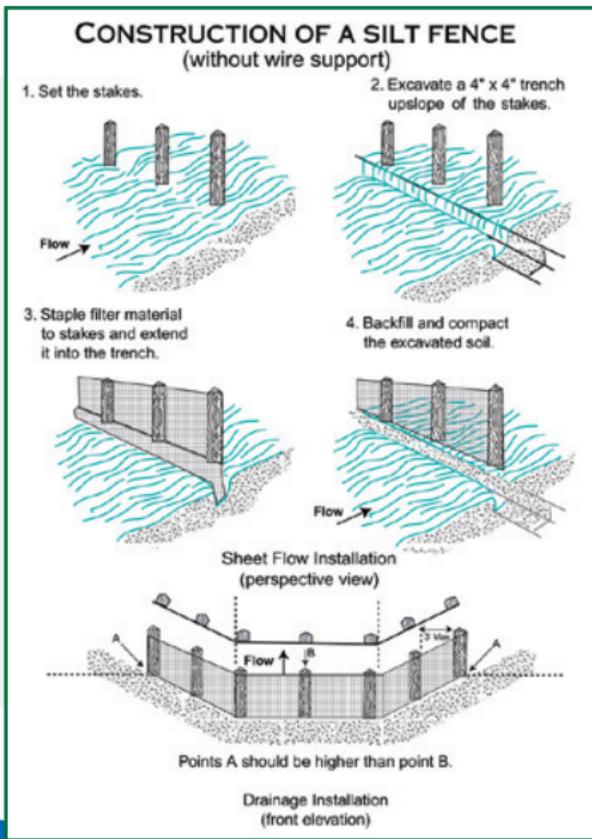
A brush barrier is a temporary sediment barrier constructed at the perimeter of a disturbed area, such as log decks adjacent to the SMZ or skid trails in the bottom of swales. The purpose of the brush barrier is to intercept and retain sediment from disturbed areas to prevent sediment from leaving the site.



Erosion Control Measures

Silt Fence

A temporary sediment barrier consisting of a synthetic filter fabric stretched across and attached to supporting posts and entrenched to a depth of four inches.

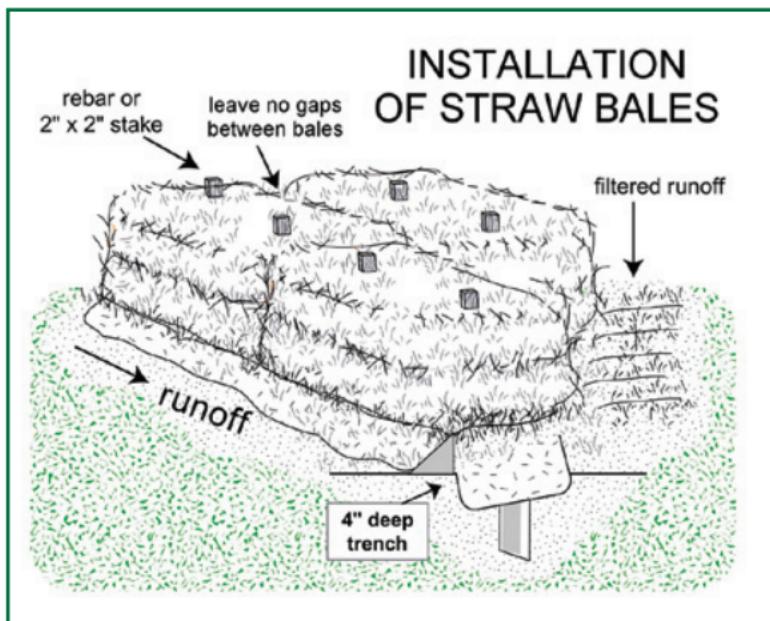


Erosion Control Measures

Straw Bale Barrier

A temporary sediment barrier consisting of entrenched and anchored straw bales.

- Decreases the velocity of sheet flows.
- Intercepts small amounts of sediment from disturbed areas.

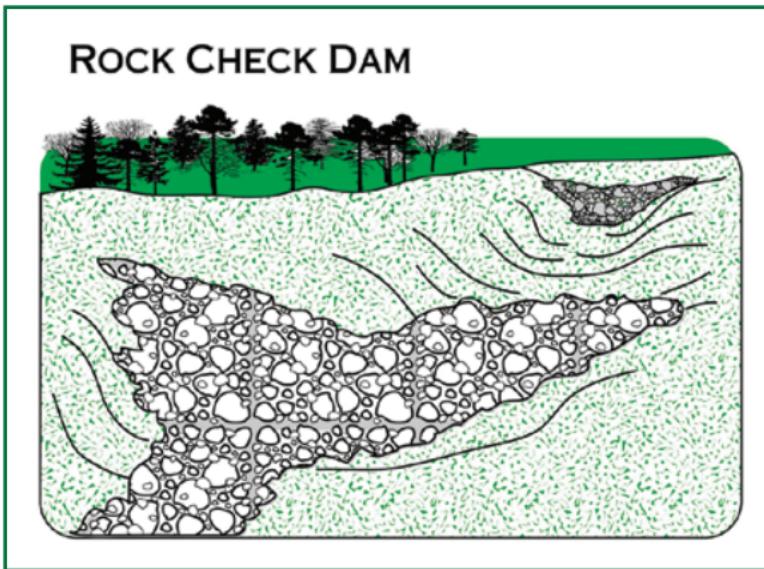


Erosion Control Measures

Rock Check Dams

Small temporary stone dams constructed across a swale or drainage ditch.

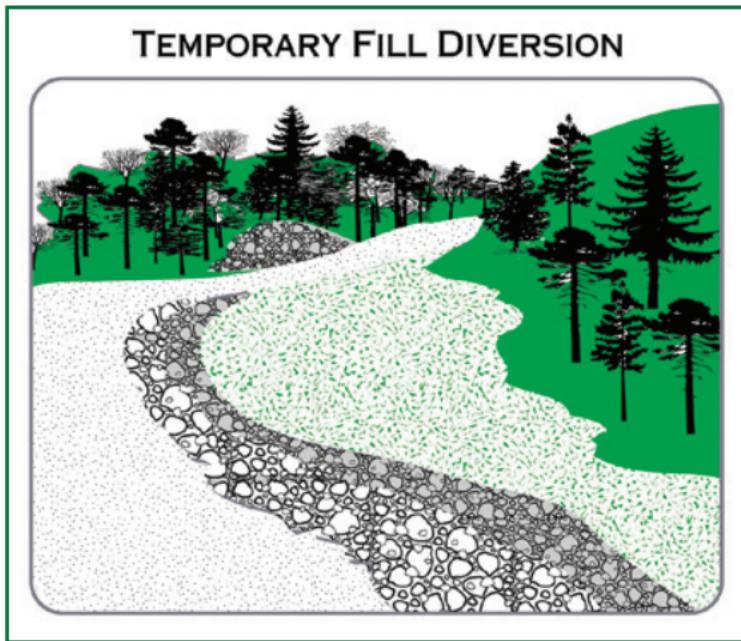
- Effective in reducing the velocity of water moving in a drainage ditch, thereby reducing the erosive potential of the water in the ditch.
- An aid in sediment trapping for forestry operations.



Erosion Control Measures

Temporary Fill Diversion

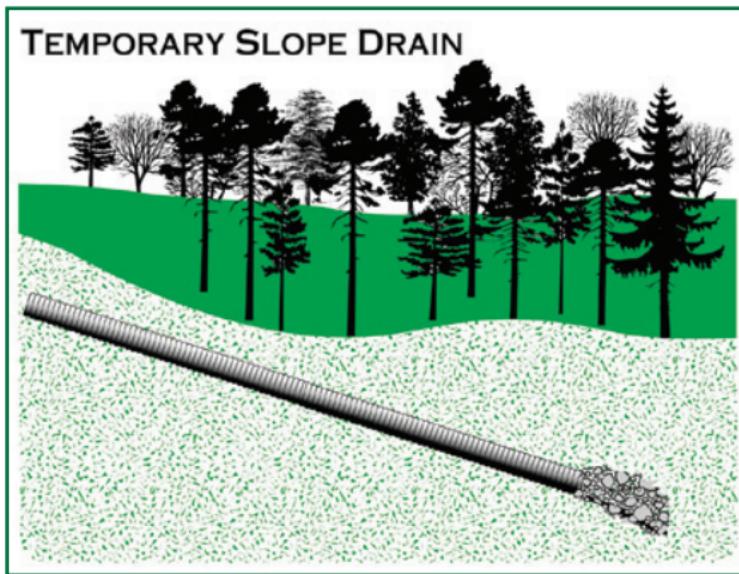
Usually found along the edge of a road where an “active fill” is present directly below the road edge. This diversion will keep drainage from the road surface from crossing the exposed fill and eroding it down-slope. Generally, the water from such a fill diversion is directed to a temporary slope drain, or a vegetated or rock-lined ditch.



Erosion Control Measures

Temporary Slope Drain

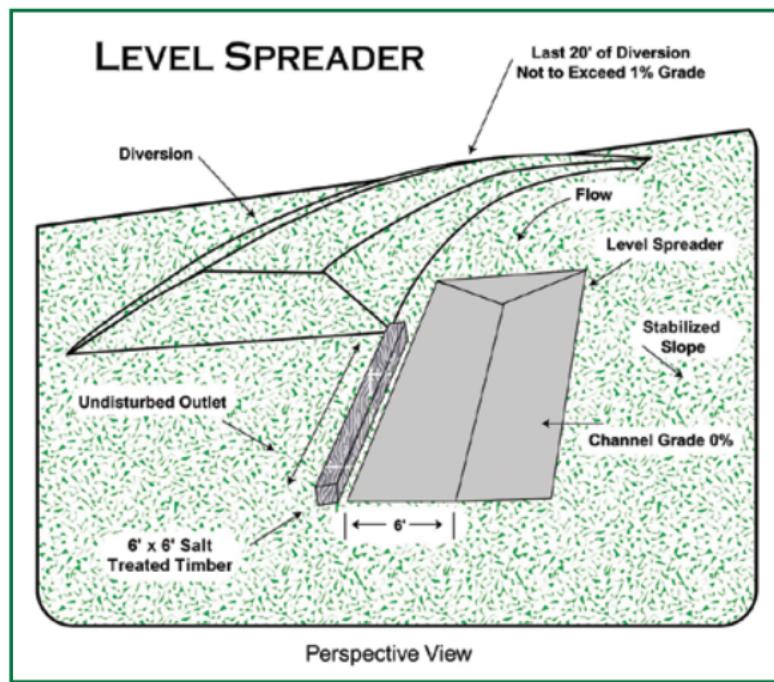
A flexible tubing or conduit used to direct water from a road surface to the bottom of a fill slope. This will prevent erosion of the fill slope. This will also allow for the stabilization with vegetation of the fill slope.



Erosion Control Measures

Level Spreader

An outlet for drainage structures and diversions consisting of an excavated depression constructed at zero grade across a slope.



Erosion Control Measures

The level spreader will release directed flow from a drainage structure, such as a lead-off ditch, to a zero grade and release it into the undisturbed forest area as sheet flow.

The following additional BMP measures can be found in the full manual, *Virginia's Forestry Best Management Practices for Water Quality, Fifth Edition, May 2009*:

- ◆ Sediment Traps
- ◆ Geoweb® improved stream crossings
- ◆ Geotextile
- ◆ Mulching
- ◆ Erosion Control Blankets
- ◆ Surface Roughening

Revegetation

Soil stabilization practices are necessary where soil is exposed and is likely to erode to adjacent streams. Stabilization through revegetation is recommended on all bare soil areas that exceed five percent slope or on highly erodible soils. Bare soil areas should be stabilized immediately following harvest by using the recommended specifications and seeding tables that follow. For further assistance, contact the Department of Forestry; Soil and Water Conservation Districts, or the Department of Game and Inland Fisheries.

Specifications for Revegetation

- Select a seed mix appropriate for the conditions and the season of the year to ensure success.
- Install all necessary water control structures prior to seeding.
- Adequate seed bed preparation is essential to the successful germination of the seed. Surface roughening may be required.
- An application of mulch during the dry summer months and in the fall can help in the establishment of the vegetation.

Revegetation

- Lime and fertilizer is generally required. It is recommended that a soil test be done to determine the correct quantities. In general, in areas with acidic soils, 1.5 tons of lime per acre and 600 pounds of 10-10-10 fertilizer will assist germination and survival.

Please refer to the following tables for:

Seeding Mixtures and Guidelines for Revegetation of Critical Areas in Virginia

**Choose a mixture of Main Crop, Legumes and
Grains/Grasses to equal a total of 100 to 150
pounds per acre seeding rate.**

Revegetation

Main Crop

Choose one of the following or a combination:

Table 10. Main Crop Seeding Rates and Times

Seeding Mixture	Rate/Acre	N. Piedmont, Mountains, Valley	S. Piedmont, Coastal Plain
Perennial Ryegrass K-31 Fescue	Total 60 - 70 lbs. /acre	Feb. 15 - May 15 Aug. 15 - Nov. 15	Feb. 1 - Apr. 15 Sep. 15 - Nov. 15

Choose one rye, perennial rye and/or fescue as a main crop grass. A combination can also be used in fall plantings.

Use of annual rye outside peak seeding times is beneficial as a quick, temporary cover.

Revegetation

Legume

Choose one of the following or a combination:

Table 11. Legumes Seeding Rates and Times

Seeding Mixture	Rate/Acre	N. Piedmont, Mountains, Valley	S. Piedmont, Coastal Plain
Kobe orrean L. Koespediza	15 lbs./acre	N/A	Mar. 1 - May 15
Hairy or Woodford	15 lbs./acre	N/A	Feb. 1 - May 15
Bigflower	15 lbs./acre	Feb. 15 - May 1	N/A
Lathco Flatpea Alfalfa	25 lbs./acre	Sep. 1 - Nov. 1	N/A

A legume will provide wildlife food and cover and add nitrogen to the soil. Choose one or a combination in addition to your main crop.

Revegetation

Grains and Grasses

Choose one of the following or a combination:

Table 12. Grains and Grasses Seeding Rates and Times

Seeding Mixture	Rate/Acre	N. Piedmont, Mountains, Valley	S. Piedmont, Coastal Plain
Weeping Lovegrass	20 lbs./acre	Mar. 15 - May 15	N/A
Foxtail Millet	20 lbs./acre	May 15 - Aug. 15	May 1 - Sep. 1
Hybrid Bermudagrass	15 lbs./acre	N/A	Mar. 1 - May 15

Adding additional grains and grasses ensures plant diversity if the main crop does not successfully seed. Many of these grasses produce grain seeds critical to game birds. Use weeping lovegrass on steep slopes when seeding in warm seasons.

Revegetation

Critical Planting Area

Mulching should always occur for critical area planting at rates of two to four tons of mulch per acre. If this type of planting occurs in mid-winter, consider mulch only until the spring seeding period occurs.

Table 13. Seeding Mixtures and Rates

Seeding Mixture		
Late Winter/Spring	Rate/1,000 sq. ft.	Rate/acre
Oats	2 lbs.	95 lbs.
Rye	3 lbs.	140 lbs.
Ryegrass	1 lb.	45 lbs.
Oats & Ryegrass	1/2 lb. - 1 lb.	45 - 60 lbs.
Oats & Korean Lespedeza	1/2 lb. - 1 lb.	45 - 60 lbs.
Summer	Rate/1,000 sq. ft.	Rate/acre
Sundangrass	1 lb.	35 - 45 lbs.
Brown top Millet	1 lb.	30 - 40 lbs.
Weeping Lovegrass	5 lbs.	25 lbs.
Late Summer/Early Winter	Rate/1,000 sq. ft.	Rate/acre
Rye	3 lbs.	140 lbs.
Ryegrass	1 lb.	45 lbs.
Oats (before Oct. 1)	2 lbs.	90 lbs.
Barley (before Oct. 15)	3 lbs.	140 lbs.
Wheat (after Oct. 1)	3 lbs.	140 lbs.

Regulations

Federal Clean Water Act – Mandated Road BMPs for Wetlands

1. Roads and trails for forestry in U.S. waters must be minimal in number and area, consistent with silvicultural operations and topographic and climate conditions.
2. All roads must be far enough from streams or water bodies (except those crossing these waterways) to minimize dredge/fill discharge in U.S. waters.
3. Road fill must be bridged, culverted or otherwise designed to prevent the restriction of expected high flows.
4. The fill must be properly stabilized and maintained during and following construction to prevent erosion.
5. Discharges of dredge/fill material into U.S. waters to construct road fill must be done so as to minimize the encroachment of trucks, tractors, bulldozers or other heavy equipment within (into) U.S. waters and wetlands that lie outside the lateral boundaries of the fill.
6. In designing, construction and maintaining roads, negative disturbance in U.S. waters must be kept to a minimum.

Regulations

7. The design, construction and maintenance of the road crossing must not disrupt the movements of aquatic species living in the water body.
8. Borrow material must be taken from upland sites when feasible.
9. Discharges must not take, jeopardize, adversely modify or destroy the critical habitat of threatened or endangered species as defined under the Endangered Species Act.
10. Discharges into wetlands and into breeding, nesting and spawning areas for waterfowl must be avoided if less harmful alternatives exist.
11. Discharges must not be located in the proximity of a public water supply intake.
12. Discharges must not occur in areas of concentrated shellfish production.
13. Discharges must not occur in part of the National Wild and Scenic Rivers System.
14. Discharges must not contain toxic pollutants in toxic amounts.
15. Temporary fills must be entirely removed and the area restored to its original elevation.

Regulations

Silvicultural Operations in Chesapeake Bay Preservation Areas

Silvicultural activities in Chesapeake Bay Preservation Areas are exempt from [the] regulations provided that [the] silvicultural operations adhere to water quality protection procedures prescribed by the Department of Forestry in its *Forestry Best Management Practices Handbook for Water Quality in Virginia*. [Fifth Edition, May 2009, now titled *Virginia's Forestry Best Management Practices for Water Quality*.]

Check with the local Department of Forestry Office, local government zoning officer, or Virginia Department of Conservation and Recreation Chesapeake Bay Local Assistance Office for further information regarding this Law.

Silvicultural Water Quality Law

This section of the *Code of Virginia* (§10.1-1181.1 through 10.1-1181.7) refers to the Silvicultural Water Quality Law. This law gives the State Forester legal authority to protect water quality from excessive sedimentation originating from silvicultural operations on any stream in Virginia.

This law allows the State Forester to issue Special Orders or Emergency Special Orders that will require implementation

Regulations

of corrective measures, and to impose civil penalties of up to \$5,000 per violation, with each day of a continuing violation being considered a separate violation. These orders and penalties involve all owners and operators involved in the silvicultural activity.

The law also requires that operators notify the State Forester prior to the start of a silvicultural activity.

Please refer to the *Code of Virginia* for specific language regarding this law, or contact your local Department of Forestry field office for specific information regarding this law.

Debris in Streams Law

§ 62.1-194.2. Throwing trash, etc., into or obstructing river, creek, stream or swamp.

It shall be unlawful for any person to throw or otherwise dispose of trash, debris, tree laps, logs, or fell timber or make or cause to be made any obstruction which exists for more than a week (excepting a lawfully constructed dam) in, under, over or across any river, creek, stream, or swamp, so as to obstruct the free passage of boats, canoes, or other floating vessels, or fish in such waters. The provisions of this section shall be enforceable by duly authorized state and local law-enforcement officials and

by conservation police officers whose general

Regulations

police power under § 29.1-205 and forest wardens whose general police powers under § 10.1-1135 shall be deemed to include enforcement of the provisions of this section. Violations of this section shall be punishable as a misdemeanor under § 18.2-12; and each day for which any violation continues without removal of such obstruction, on and after the tenth day following service of process on the violator in accordance with § 19.2-75, shall constitute a separate offense punishable as a misdemeanor under § 18.2-12.

Regulations

Agency Listing

Virginia Department of Forestry

Notification of Logging Operations Line
www.dof.virginia.gov
1-800-939-LOGS (1-800-939-5647)

For information and assistance in the areas of Harvest Planning, Water Quality Law and/or general assistance, contact:

Forest Management Division - Water Quality
Virginia Department of Forestry
900 Natural Resources Drive, Suite 800
Charlottesville, Virginia 22903
Phone: (434) 977-6555

Or one of the regional offices listed below:

Western Region	Salem	(540) 387-5461
	Abingdon	(276) 676-5488
Central Region	Charlottesville	(434) 977-5193
	Farmville	(434) 392-4159
Eastern Region	Tappahannock	(804) 443-2211
	Waverly	(804) 834-2300

Agency Listing

Virginia Marine Resources Commission

For information and assistance on stream-crossing permits for drainage areas more than 3,000 acres:

Virginia Marine Resources Commission
2600 Washington Avenue
Newport News, Virginia 23607-0756
Phone: (757) 247-2200

Virginia Department of Game and Inland Fisheries

For information and assistance on wildlife and habitat protection:

Virginia Department of Game and Inland Fisheries
4010 West Broad Street, Post Office Box 11104
Richmond, Virginia 23230-1104
Phone: (804) 367-1000

Virginia Department of Conservation and Recreation - Division of Natural Heritage

For information regarding rare, threatened or endangered species:

DCR – Division of Natural Heritage
217 Governor Street
Richmond, Virginia 23219
Phone: (804) 786-7951 or (804) 371-2708

Agency Listing

DCR Division of Chesapeake Bay Local Assistance

For information and assistance on whether your harvest area lies within the Chesapeake Bay Resource Protection Area, you may contact CBLAD at the following address and phone number; your local county zoning official, or VDOF.

Chesapeake Bay Local Assistance Division
James Monroe Building, 101 North 14th Street, 17th Floor
Richmond, Virginia 23219
Phone: 1-800-ChesBay (243-7229); (804) 225-3440

Virginia Department of Environmental Quality

For information and assistance regarding oil spills:

Virginia Department of Environmental Quality
629 East Main Street
Richmond, Virginia 23219
Phone: (804) 698-4000

Department of Mines, Minerals and Energy

To purchase topographic maps for harvest planning:

Department of Mines, Minerals and Energy
Division of Geology and Mineral Resources
900 Natural Resources Drive, Suite 500
Charlottesville, Virginia 22903-0667
Phone: (434) 951-6340

Agency Listing

U. S. Army Corps of Engineers

For information and assistance on wetlands and permitting:

U. S. Army Corps of Engineers
Norfolk District Office
803 Front Street
Norfolk, Virginia 23510-1096
Phone: (757) 201-7655

You will be put in touch with the correct field office.

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