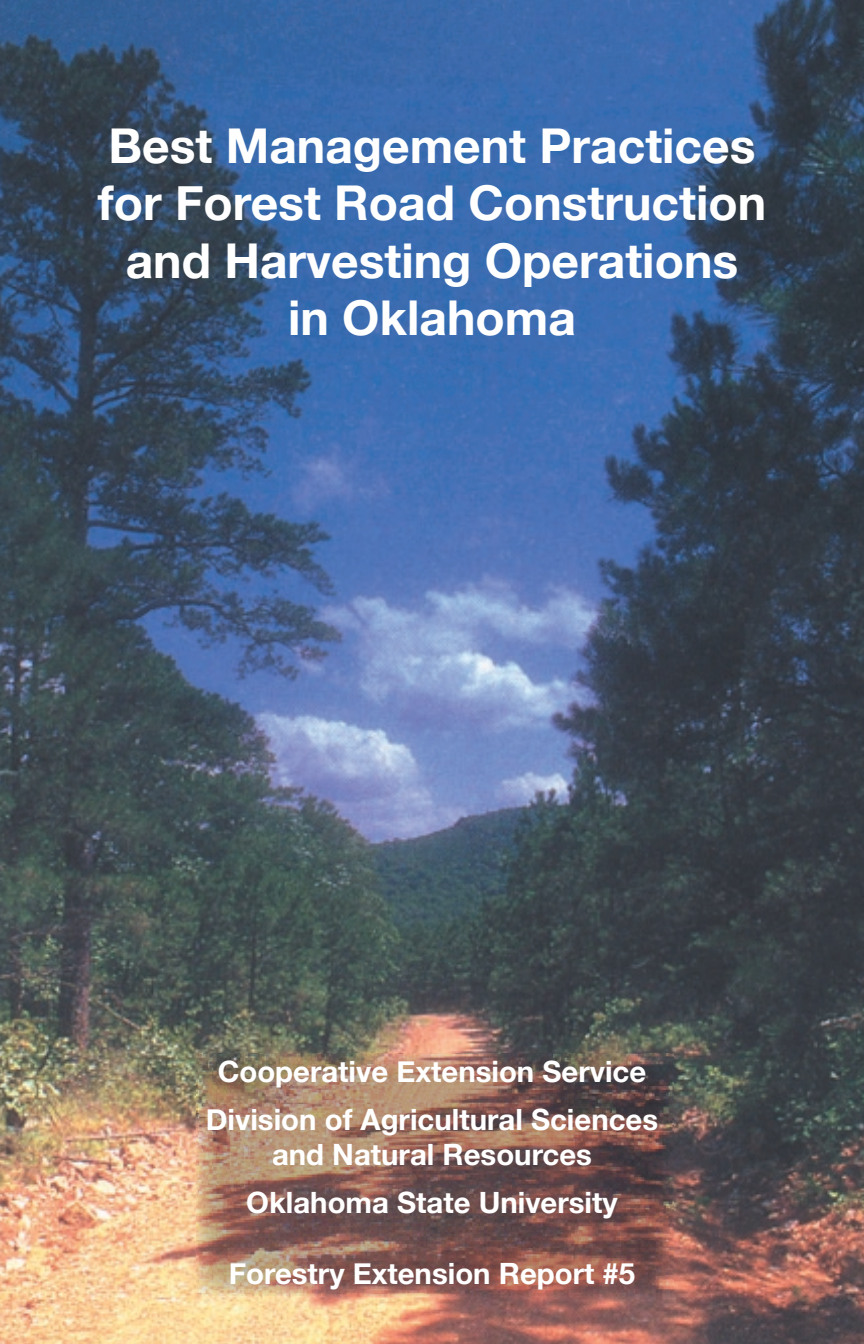

Best Management Practices for Forest Road Construction and Harvesting Operations in Oklahoma

Cooperative Extension Service

Division of Agricultural Sciences and Natural Resources

Oklahoma State University

Forestry Extension Report #5

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Introduction

A plentiful supply of clean water is one of the most valuable natural resources produced by Oklahoma's forest lands. Timber harvest, site preparation, and road construction and maintenance can affect water quality. However, with the application of common sense and low-cost best management practices (BMPs), timber products may be harvested with minimal impact on water quality. BMPs are not currently regulated in Oklahoma.

The success of the nonregulatory approach and avoidance of government regulation of logging activities may depend on development of forest management plans that address BMPs. When timber is harvested, the landowner's management plan should be consulted. Cooperation between the logger (or timber buyer) and landowner will ensure that BMPs are applied to the land.

This guide presents basic recommendations for the road construction and logging practices that are most important in protecting streams and water quality.

Streamside Management

Proper streamside management is one of the most important practices you can consider to help maintain water quality. Care is needed during road construction and harvesting to protect streams and streambanks from erosion. Streamside vegetation and land buffers protect streambanks and stream channels from erosion, cool stream water by providing shade, and help to filter sediment and nutrients from disturbed areas.

Strips of land left between streams and disturbed areas are commonly known as streamside management zones (SMZs) (Figure 1). Management practices may be modified in an SMZ, depending on the landowner's objectives. Follow these guidelines when operating near streams:

- Establish and operate within the SMZs in accordance with the landowner's forest management plan.
- Leave a minimum of 50 feet between roads and streams.
- Before logging, mark a SMZ between streams and harvested areas or roads. Width of SMZ will depend on local conditions.* A minimum width of 50 feet on each side of the stream is a good rule of thumb.
- Keep skidders away from streambanks.
- Under wet conditions, keep heavy equipment out of SMZ. Use a cable skidder if available.
- Do not skid across streams.
- Remove tops or large limbs from stream channels.

* Widths should be adjusted for slope and other site conditions. Consult with the agencies listed in the back of this document.

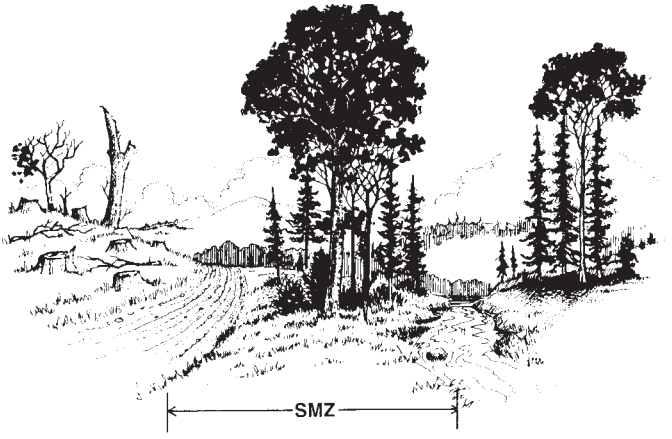


Figure 1. A typical Streamside Management Zone

Forest Roads

Erosion from forest roads is the major source of sediment from forestry operations. Plan ahead! In order to ensure fairness to both the logger and landowner, the road system should be part of an overall forest management plan. Early planning will save time and money as well as protecting water quality.

Road planning involves decisions that are of concern to both the logger and the landowner. Therefore, loggers and landowners should plan together. Planning involves such factors as making choices between permanent and temporary roads, relocation and repair of existing roads, type and number of stream crossings, alternative access points, and the expected use of the roads by the landowner and logger.

Existing Roads: Repair or Relocate?

Many forested tracts in Oklahoma already have existing roads. Use existing roads whenever possible. Unfortunately, many of these existing roads are eroding and have washed-out areas due to lack of maintenance or bad location and design. Old roads may not meet present BMP guidelines for design or location. If existing roads can be improved to meet current standards, they should be used, as new road construction or relocation of existing roads can be expensive and may cause significant erosion and sediment movement in the short term.

Consider the effects of construction, continued use, and maintenance when making decisions as to whether to use existing roads or construct new ones.

Decisions on whether or not to improve or relocate existing roads may require experienced judgment. In such cases:

- Apply BMPs to the degree possible within the limitations of the road system.
- Relocate roads only if it will result in less erosion in the long term.
- Consult the forest management plan or the agencies listed.

Temporary Roads

Where timber harvest occurs infrequently and future access for recreation and fire control is not needed, temporary roads should be used. Temporary roads are used during harvest operations and promptly closed. In general, temporary roads cost less. They are recommended for landowners who are away from their property for extended periods and cannot perform the constant maintenance required by permanent roads. However, poorly located and installed temporary roads may erode and become permanent gullies.

Follow the location, design, erosion control, stream crossing, and closure guidelines listed in this guide.

Permanent Roads

Permanent roads may be necessary to provide future access for recreation, fire control, and timber harvest. Permanent roads are expensive and usually require a greater amount of soil disturbance during construction. Permanent roads also require regular maintenance.

Road Location Guidelines

The following location and design guidelines are for rehabilitated old roads, new roads, temporary roads, and permanent roads, except where noted.

- Plan ahead!
- Use the minimum number of roads necessary to get the job done.
- Minimize stream crossings.
- Allow for properly sized SMZs when locating roads.
- Keep roads out of SMZs except at stream crossings.
- Avoid unstable and poorly drained areas.
- Locate roads along ridges whenever possible.

Road Design Guidelines

- Use the smallest road needed for the planned use.
- Use temporary roads whenever possible.
- Use gravel to surface high-traffic roads.
- Keep sustained grades on permanent roads to no more than 10 percent. Allow grades up to 18 percent where pitches are short and steep, but not more than 500 feet long.
- Balance road cuts and fills. Do not borrow from roadside slopes.

Road Erosion Control Guidelines

The main objective of erosion control on forest roads is to keep water from accumulating and concentrating on the road surface. Fast-moving water can readily erode soil from road surfaces. When water is dispersed at regular intervals, road erosion can be controlled.

Road Cross-sections

The commonly used road cross-section designs are crowned, outsloped, and insloped (Figure 2).

Crowned roads may be used in all terrains. Water turnouts and cross-drains must be provided.

Outsloped roads may be built in moderately sloping terrain, such as roads on upper parts of long slopes.

Outsloped roads are not suitable for deeply cut side-hill roads or in locations where upslope drainage areas are large.

Insloped roads may be used on sharp, steep turns as a safety precaution.

Cross-drain Culverts

Cross-drains provide drainage relief to upslope ditches. To minimize ditch erosion and prevent washouts, space cross-drains more closely on steeper slopes (Table 1).

Culvert size should be selected according to the road area and hillslope area drained by the ditch (Table 2). To avoid clogging, do not use culverts smaller than 12 inches in diameter.

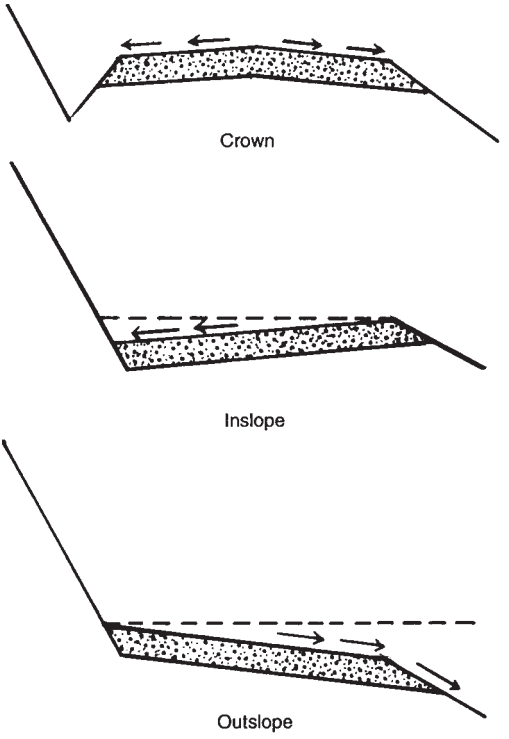


Figure 2. Road Surface Cross Sections (road surface slope - one half inch per foot)

Table 1

Recommended Spacing of Cross-drain Culverts

Road Grade (%)	Spacing (feet)
2-5	500-300
6-10	300-200
11-15	200-100
16-20	100

Table 2

Recommended Diameters of Culverts Based on Drainage Area

Pipe Diameter (inches)	Area Above Pipe (acres)
12	2
15	4
18	7
21	12
24	16
30	27
36	47
42	64
48	90
54	120
60	160
66	205
72	250
78	350

Culvert Installation

Plug the ditch immediately downhill of the culvert inlet to direct all water into the culvert (Figure 3).

Extend the culvert outlet beyond the fill slope. Install rocks or slash at the outlet to prevent erosion by concentrated flow.

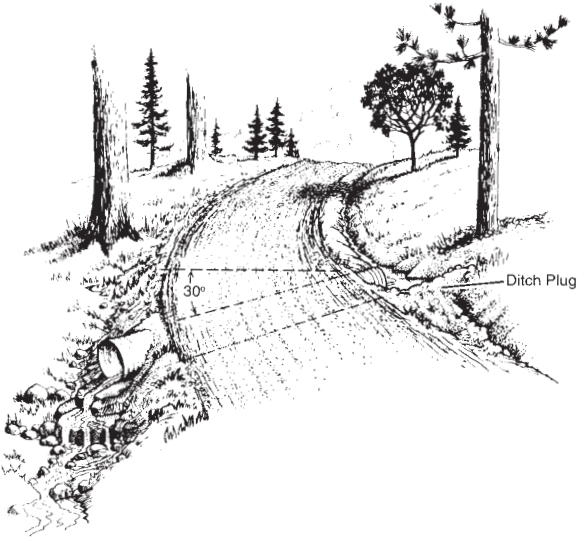
- Angle culverts 30 degrees downslope.
- Make culvert gradients at least two percent greater than the ditch gradient.
- Locate culverts so they do not outlet directly into streams.

Drainage Dips

Drainage dips provide cross drainage and drainage of water that collects on road surfaces. Dips can be used instead of cross-drain culverts, usually at lower cost. They are especially well suited for temporary roads. Dips must be deep enough to provide adequate drainage, but wide enough to allow the safe passage of trucks and equipment. The type of dip selected depends on expected use and type of road. The spacing of drainage dips is determined by slope steepness and local conditions (Table 3 on page 15). Place rock or slash below the outlet to prevent erosion.

Rolling dips (Figure 4) are best for spur and temporary roads that have little traffic at low speeds. Rolling dips resemble “stretched out” water bars. The dip is excavated out of the existing road grade.

Broad-based dips (Figure 5) are best for roads with high traffic volumes and speeds, such as permanent main haul roads. The road grade between dips is adjusted so there is a constant grade from the crest of the berm of one dip to the bottom of the next dip downslope.



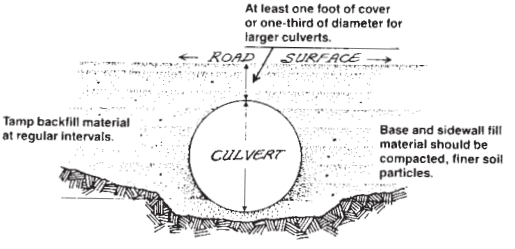


Figure 3. Design and Installation of Cross-drain Culverts (adapted from Montana Forestry BMPs, Montana State University)

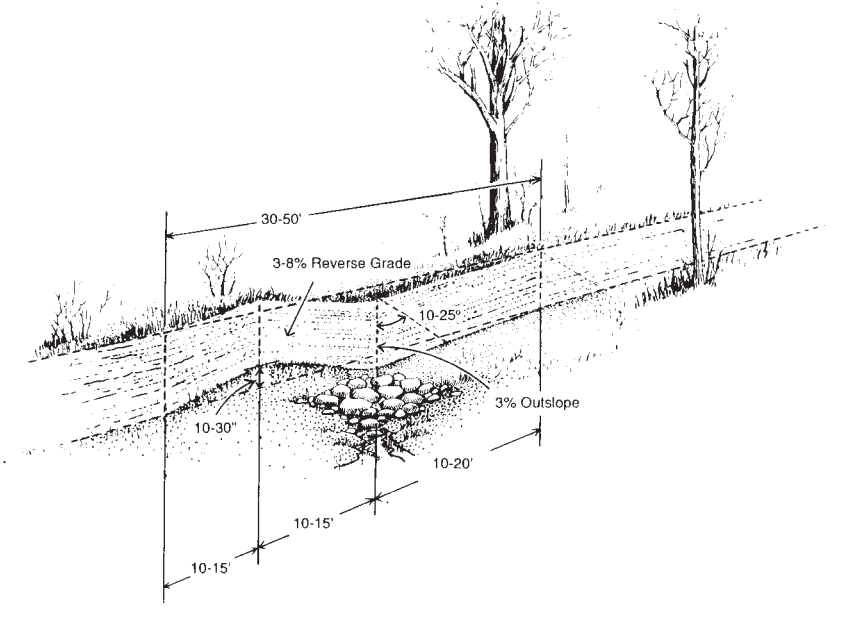


Figure 4. A Rolling Dip

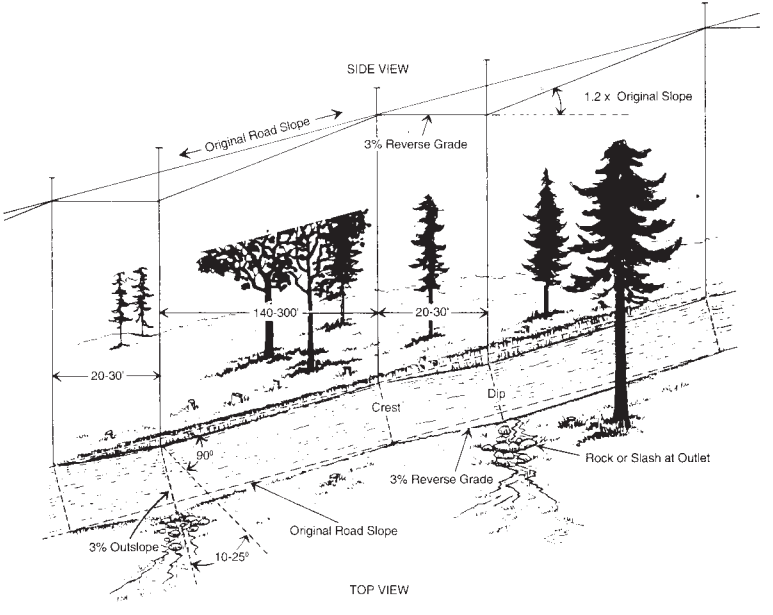


Figure 5. A Broad-Based Drainage Dip

Table 3

Drainage Dip Spacing

Road Grade (%)	Spacing (feet)*
2-4	300-200
5-7	180-160
8-10	150-140

*Reduce spacing on highly erodible soils

Water Bars

Water bars (Figure 6) provide needed removal of road surface water on inactive or closed roads.

Water Bar Installation

- Install water bars at a 10- to 25-degree angle downslope.
- Provide a cross-drainage grade of one to two percent.
- Place rock or slash below the outlet.
- Space water bars more closely on steeper slopes (Table 4).

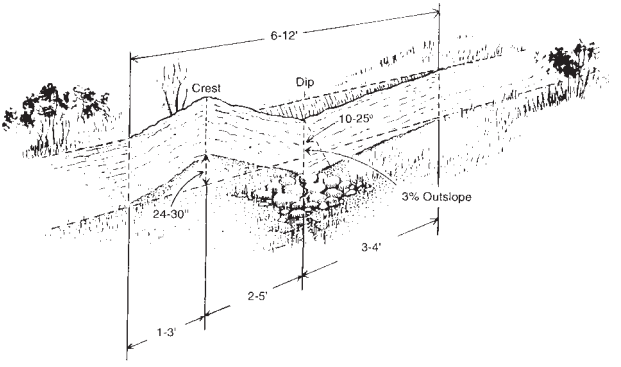


Figure 6. Design of Water Bars

Table 4

Recommended Water Bar Spacing for Roads and Skid Trials

Grade of Road (%)	Water Bar Spacing (feet)
2	250
5	135
10	80
15	60
20	45
25	40
30	35
40	30

Turnouts or Wing Ditches

Turnouts (Figure 7) provide drainage of ditch water from roads on ridges, points of ridges, and gentle sideslopes. On flat roads, turnouts provide drainage and help the road dry out.

Turnout Installation

- On sloping roads, use the spacing guidelines for cross-drain culverts (see Table 1).
- Intersect the ditch line at the same depth and outslope one to three percent.
- Turn at a 30- to 40-degree downslope angle (with respect to the road bed).
- Place rock and slash at the outlet to prevent erosion where needed.
- Do not outlet turnouts into stream channels.

Mulching and Seeding

To reduce erosion and promote vegetation, mulch or slash should be applied to highly erodible areas (Table 5). Apply mulch or slash to skid trails, new cut and fill banks, landings, or any other bare erodible soil near drainage channels. Seeding may be necessary in some instances where immediate ground cover is desirable.

Figure 7. Installation and Design of Turnouts

Table 5

Recommended Dates for Seeding and Planting Operations

Species	Dates
Native grass mixture-warm season	Dec 1 - May 15
Native grass mixture-cool season	Sep 1 - Mar 31
Native Legumes and Clovers*	Sep 1 - Mar 31
Bermuda grass-Southern Oklahoma	Dec 1 - May 31
Bermuda grass-Northern Oklahoma	Feb 1 - May 31
Woody vegetation: hardwoods, conifers, and shrubs	Dec 1 - Mar 15

* Avoid invasive species such as sericia lespedeza and old world bluestem.

Stream Crossings

Crossing streams during logging operations presents special problems. Equipment operating in or near stream channels may add sediment directly to streams. Crossings that are poorly located or constructed may destabilize streambanks and cause channel erosion. If it is available, follow the forest management plan when locating and designing stream crossings.

The following guidelines are intended for crossing small streams that flow only during part of the year or minor hillside channels that carry water only during rainstorms. Where logging operations require the construction or repair of crossings on major streams, consult a qualified consultant or the Water Quality Forester for the Forestry Services Division, Oklahoma Department of Agriculture, Food, and Forestry.

- Avoid logging during wet periods.
- Use cross-drains and turnouts to remove water from road surfaces and ditches before reaching stream crossings.
- Minimize stream crossings by good road planning. Follow the forest management plan.
- Always cross streams at right angles.

Types of Crossings

Types of crossings that can be ordinarily used during and after logging include culverts, concrete slabs, rocked fords, log or timber bridges, and log and brush-lined fords.

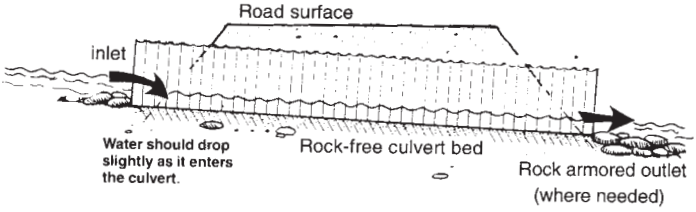
Culverts. Use properly sized and installed culverts (Table 2 and Figure 8). Do not obtain culvert fill material from within the stream channel!

Concrete Slabs and Rocked Fords. Depending on the soil, streambank and channel conditions, satisfactory crossings can be made with low-water concrete slabs and rocked fords (Figure 9). Concrete slabs are suitable for high-use permanent roads. Rocked fords may be suitable for temporary and permanent roads, depending on use and local conditions.

Bridges. Bridges vary in expense and design, depending on stream channel conditions, expected use, and whether or not a road is temporary or permanent. “Portable” bridges work well on temporary roads that cross small streams. Inexpensive log or timber bridges (Figure 10) may be suitable for temporary or permanent roads.

Log and Brush-Lined Fords. The use of brush or cull logs to armor temporary stream crossings is a common and inexpensive practice suitable for minor hillside channels.

Promptly remove all material from the channels when logging is completed.



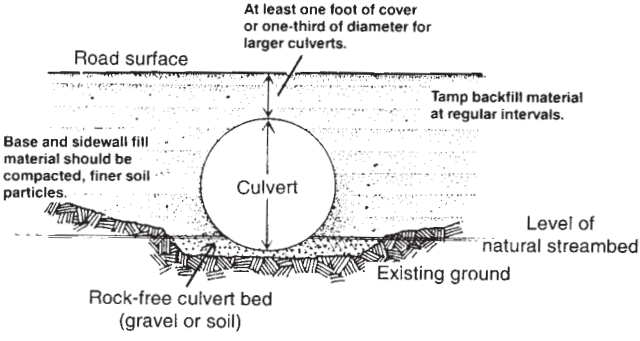


Figure 8. Installation of Stream Crossing Culverts (adapted from Montana Forestry BMPs, Montana State University)

Where channels are shallow and rock-lined already, crossings may be made without additional structures, providing the use is light. When questions arise, consult the listed agencies.

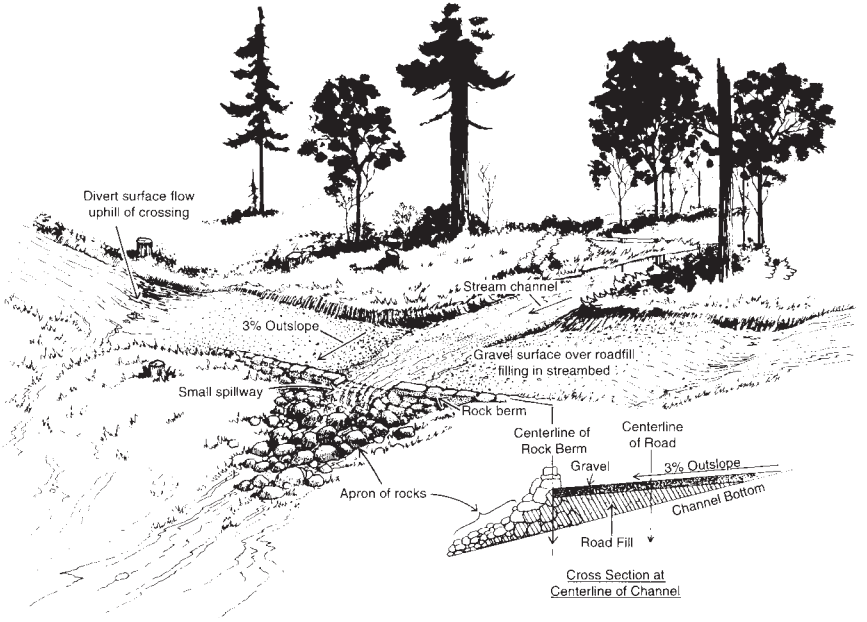


Figure 9. A Typical Rocked Ford

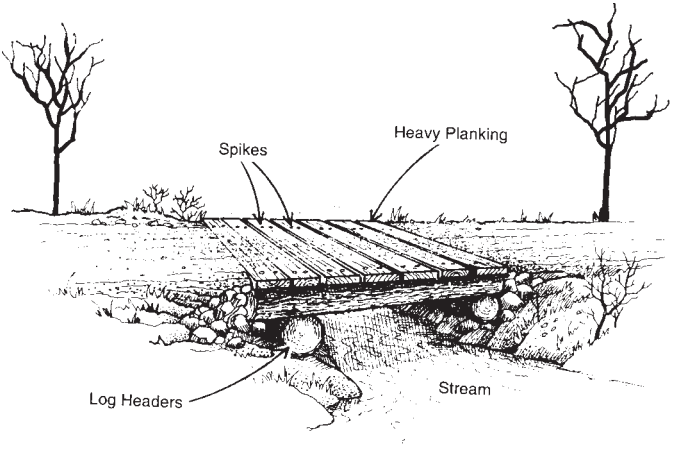


Figure 10. A Low-Cost Log and Plank Bridge

Road Maintenance

Road maintenance is as important to water quality as drainage control and streamside management. It is the landowner's responsibility to maintain roads after logging is completed. Landowners who are absent or who visit their property infrequently should use low- or no-maintenance practices (such as temporary roads and water bars).

Maintenance Guidelines

- Mulch bare, eroding roads and cut banks with slash.
- Seed badly eroding areas where necessary.
- Regularly inspect ditches, culverts, turnouts, dips, and water bars for blockage and restore to working condition.
- Limit road use during wet seasons.
- Grade road surfaces only when necessary to eliminate rutting and surface erosion channels. Grading loosens road surface materials, causing erosion.

Road Closure

Close roads that are no longer needed. Closing roads saves maintenance time and costs. Road closure is especially important for absentee landowners. If closed properly, roads can be quickly opened for access for future harvests and fire control.

Closure Guidelines

- Close temporary roads and skid trails promptly after harvesting is completed.
- Remove all temporary crossings, such as culverts, log bridges, and brush- and log-lined fords.
- Construct water bars at recommended spacings to reduce surface erosion.
- Spread slash and mulch on bare areas. Seed where necessary to protect highly disturbed areas.
- Close access points with a large ditch and berm or other structure.

Harvesting

Plan ahead! Consult with the landowner and the landowner's forest management plan. Landowners and loggers should plan haul roads, skid trails, and landings together.

Cutting

Careful felling of trees protects water quality and residual trees from damage. Felling guidelines include:

- Where possible, do not fell trees in perennial streams.
- Remove slash from stream channels.

Skid Trails

- Do not use stream channels as skid trails.
- Minimize skidding across stream channels.
- Avoid skidding in wet weather.
- Install rocked fords, log bridges, or temporary culverts when crossing stream channels.
- Periodically turn skid roads across the contour to provide drainage breaks.
- Close skid trails promptly when logging is completed. Follow the road closure guidelines previously discussed.

Landings

During Harvest

- Locate landings on well-drained, gently sloping ground.
- Keep landings outside of SMZs and away from stream channels.
- Slope the landing gently (1-2%) to allow for drainage where needed.
- Avoid concentration of run-off downslope of the landing.
- Prevent oil and fuel spills.

After Harvest

- Install a shallow ditch above the landing to divert run-off where needed.
- When skidding and hauling is complete, grade out any ruts to form a smooth surface.
- Cover bare soil with slash.
- Seed where necessary.

Additional Information

Other forest management activities that may affect water quality include site preparation, fire control, and the application of forest chemicals.

For further information and assistance in protecting water quality and proper forest management, contact:

Forestry Services Division -
Oklahoma Department of Agriculture, Food, and Forestry
John Burwell, Director
2800 N. Lincoln Blvd.
Oklahoma City, OK 73105
(405) 522-6158
-or-
Water Quality Forester
Darryl Hunkapillar
PO Box 40
Broken Bow, OK 74728
(580)584-3351

Oklahoma State University
Department of Forestry
Dr. Craig McKinley, Head
011 Agricultural Hall
Stillwater, OK 74078
(405)744-5438

Oklahoma Forestry Association
P.O. Box 238
Idabel, OK 74745
(580) 326-0200

For assistance in applying BMPs in the field, contact the ODAFF-FS forester or your local County Extension Office. Also ask for videotape VT-264 “Logging, Best Management Practices, and Water Quality,” produced by OCES.

Field Offices, Forest Management and Wildfire Protection

WILBURTON, East Central Area Office
P.O. Box 297, Wilburton, OK 74578-0297
AREA FORESTER, Chris Parrington
DISTRICT FORESTER, Jason Whaley (918) 465-2082

TALIHINA, District Office
DISTRICT FORESTER, Craig Marquardt (918) 567-2021

TAHLEQUAH, Northeast Area Office
22082 South J.F. Davis Lane, Tahlequah, OK 74464-9805
AREA FORESTER, Mark Goeller
DISTRICT FORESTER, Steve Couch
SERVICE FORESTER, Dale Lenz (918) 456-6139

JAY, District Office
DISTRICT FORESTER, Andy James (918) 253-4268

SALLISAW, District Office
DISTRICT FORESTER, Bob Harrel (918) 775-2587

BROKEN BOW, Southeast Area Office
P.O. Box 40, Broken Bow, OK 74728-0040
AREA FORESTER, Tom Smith
DISTRICT FORESTER, Chris Acuff (580) 584-3351

ANTLERS, District Office
DISTRICT FORESTER, Chris Joslin (580) 298-5122

BATTIEST, District Office
DISTRICT FORESTER, Jim Langdon (580) 241-5375

GOLDSBY, Central and Western Area Office
830 NE 12th Ave. Goldsby, OK 73093-9017
AREA FORESTER, Al Myatt (405) 288-2385

WESTERN REGION SERVICE FORESTERS:

ARDMORE, Kevin Keys (580) 223-3973

ENID, Dan Stidham (580) 237-4810

BURNS FLAT, Tom Murray (580) 562-4882 ext. 115

WOODWARD, Mary Marek (580) 254-3213

GOLDSBY, Vacant (580) 288-2385

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