EROSION CONTROL on Logging Roads in the Appalachians

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WHY WORRY ABOUT A LITTLE MUD?

IN THE STEEP TERRAIN of the Appalachian Mountains much damage to forest streams is caused by erosion on logging roads. Muddy water that is unsuitable for fish, swimming, or human consumption often can be traced to these eroding roads. This paper has been prepared to sum up what land managers know about preventing and controlling erosion on logging roads in the Appalachians.

In most respects, erosion on forest roads is like erosion on farmland. The basic problem in both places is the swift flow of storm water over bare, steep ground from which the protective plant cover has been removed. The effects of some farming practices, such as cutting hay, are similar to the effects of cutting trees. Neither practice creates erosion problems because it does not expose bare soil. Also, on both kinds of land the careful manager protects the soil with a plant cover whenever possible. When harvest of the field or forest crop removes this protective plant cover, the wise land manager makes every effort to minimize damage to the exposed soil.

In the woods, roads are practically the only place where soil is dangerously exposed. The following pages tell how forest land managers can successfully cope with some of the commonest erosion problems on logging roads in the Appalachians.

For centuries we have known that erosion is rarely a problem on undisturbed forested soils. Forests are shields that protect the soil from erosion by soaking up rain faster than it falls. Leaves and twigs from the trees supply an annual addition to the soil of forest litter, which absorbs the impact of falling rain. Live roots bind forest soil together and, combined with this decaying litter, provide passageways for water into the soil. Thus surface runoff, the major cause of erosion, rarely occurs on undisturbed, litter-covered forest soils.

Although for many years some people have associated timber harvesting with deterioration of forest land and streams, experience over the last quarter-century has convinced most land managers that the mere cutting of trees is not the cause of erosion damage (fig. 1). Now we know that the real sources of this damage are the roads used to remove harvested products from the forest.

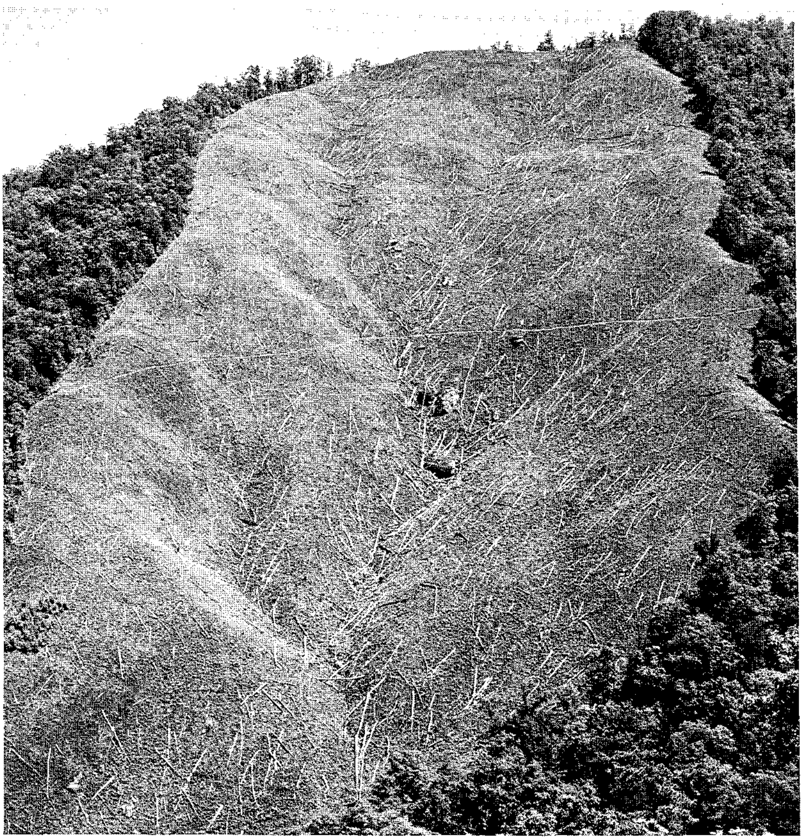


Figure 1.—Cutting all trees and leaving them where they fell on this watershed at Coweeta Hydrologic Laboratory near Franklin, N. C. did not increase erosion, nor did annually mowing the brush for 15 years afterward. The only roads constructed on this watershed were well-located contour roads barely visible in the upper part of the picture.

Although much of the original forest canopy is destroyed by cutting the trees, the litter cover is only slightly disturbed and amply protects the soil until a new canopy grows to furnish more litter.

Roads, however, present more permanent problems that often are not solved by natural vegetation, for their construction removes the all-important forest litter, which then cannot build up as long as the road is in use (fig. 2). The resulting soil compaction and loss of protective and absorbent litter prevent rain from soaking into the soil surface as rapidly as it falls. This causes water to collect on the road surface and run over exposed soils.

The runoff water moves fastest on steep roads, rapidly building up its erosive power, tearing soil loose and carrying it along, producing rutted, muddy roads over which forest products cannot efficiently be moved.

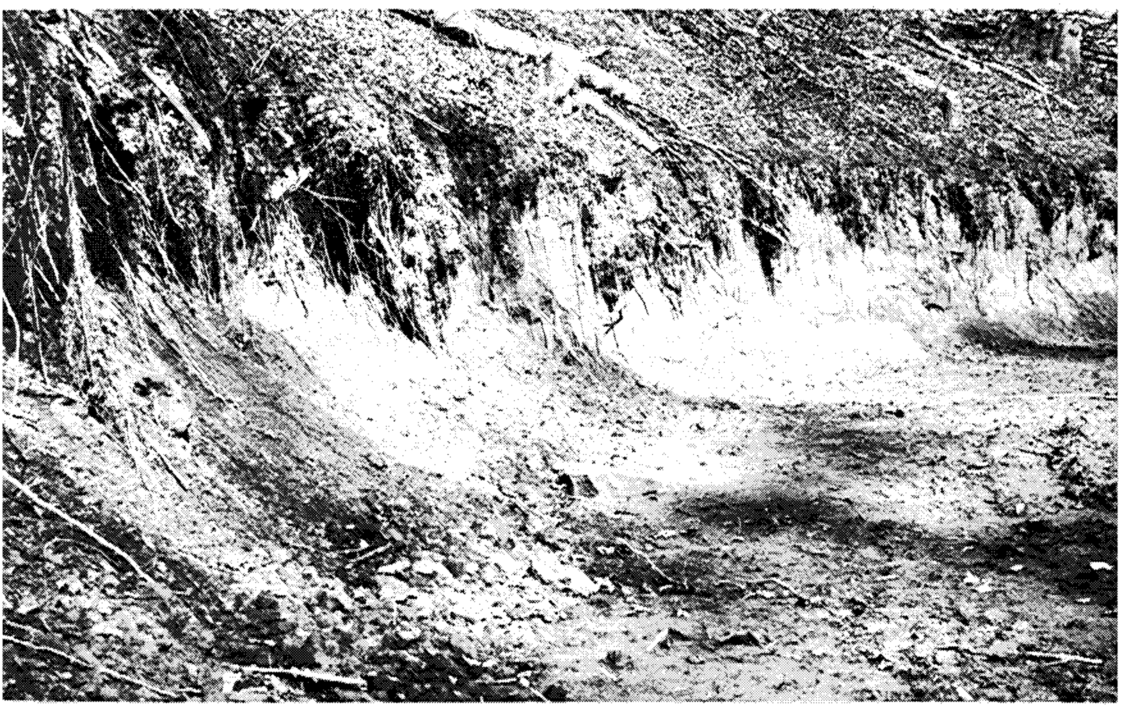


Figure 2.—Roadbuilding removes the litter that protects soil against erosion.

The erosion of roads also can contribute tremendous amounts of mud to formerly clear forest streams, destroying much of their value for men and wildlife.

Even small amounts of mud in water greatly decrease its usefulness. Visibly muddy stream water is not suitable for human consumption, and small amounts of mud are very harmful to fish that normally inhabit clear mountain streams. The economic damage is widespread, for most industries cannot use muddy water, and when sediment carried by muddy streams is deposited behind dams, their storage capacity is reduced.

PLANNING THE ROAD SYSTEM

Access always is necessary before forest resources can be used or managed, and this requires roads. Logging roads, once constructed, become a permanent part of the forest landscape. Although many logging roads are considered temporary when built, there is a good chance that they will be used to provide future access, even though they may be too steep and poorly located to provide efficient access or to protect against serious erosion damage.

Thus it is important to plan road systems that can provide permanent and efficient access to large areas without damaging other resources, such as streams, which may supply drinking water or fishing. In the past, however, most forest roads were planned to serve single logging operations with little regard to future access or damage to water supplies. Logging roads were commonly so steep that they could not be protected against erosion, or they were located next to streams, which they often polluted with sediment.

Careful planning can eliminate these undesirable practices that result in washed-out roads and silted streams (fig. 3). Planning can be made easier by using aerial photographs and topographic maps. These are valuable tools for planning logging road systems because they permit large areas to be viewed at once. This greatly facilitates the design of road systems and enables them to serve

Figure 3.—Excessive erosion and costly damage caused by poor logging-road location and lack of adequate drainage.

the largest possible areas. It also often reduces the need for steep logging roads by showing routes that avoid such obstacles as rock outcrops, property lines, and wet areas.

Careful planning can minimize the amount of land in roads. This makes for more efficient logging and is also one of the best ways to reduce erosion on logged areas. Studies on the Fernow Experimental Forest have shown that good planning can reduce skidroad area by as much as 40 percent.

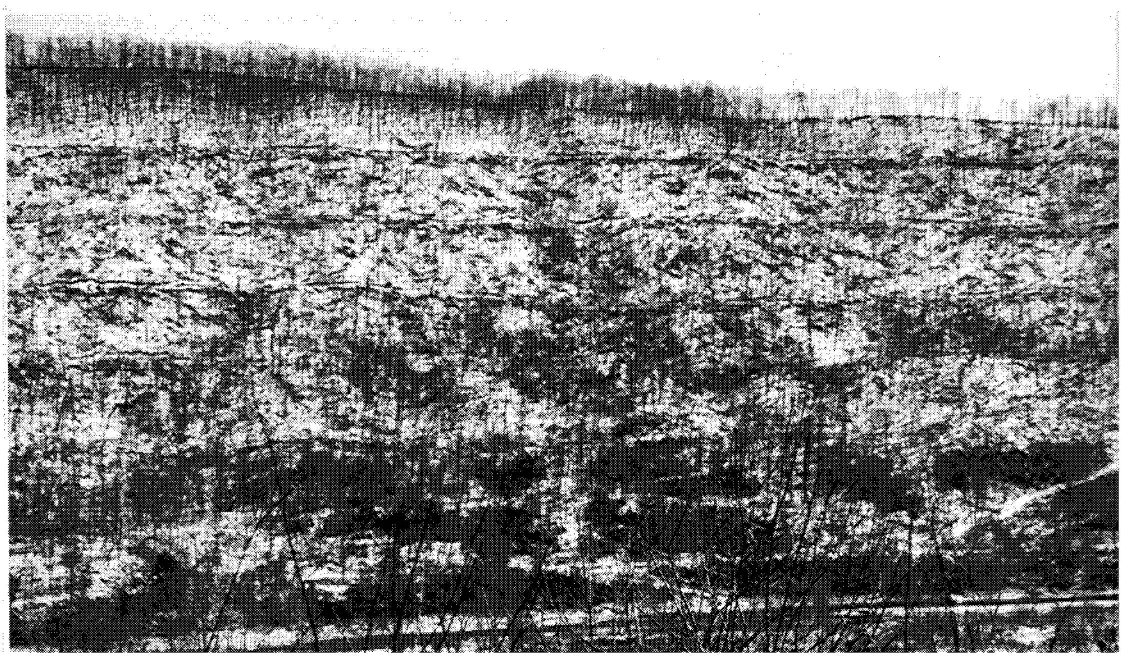
Erosion can be further reduced, and efficiency increased, by planning skidroad and truck road systems together, for skidroad grade and location, and skidding direction, usually depend on the location of logging truck roads.

Roads in steep terrain should be planned so tree-length logs can be winched uphill to them. This reduces disturbances because the ends of logs pulled uphill do not readily gouge the forest floor.

Although the best rule is to locate roads and landings as far from streams as possible, when this is not practical, logs should be winched away from streams, rather than skidded across or down streambeds. This helps to keep water clean and reduces damage to stream channels. Also, it is easier for choker setters to pull winch lines downhill, and control is better on logs pulled uphill. Once logs have been winched uphill to roads, they can either be loaded on trucks or skidded down the road to landings.

Hauling direction is another important factor in planning logging-road systems. Roads should be designed to permit downhill hauling on gentle grades because it is more economical than uphill hauling and results in less wear on equipment and road surfaces. A system consisting of one climbing road and several spur roads that closely follow the contour of the land works well in many areas of the rugged Appalachians. The climbing road takes trucks and machinery to all elevations, but logging actually is done from the spur roads that branch off from the climbing road and run on gentle grades into the timber (fig. 4).

Figure 4.—A well-planned logging-road system on topography similar to and within a few miles of the system shown in figure 5. Note that the roads closely follow the contour and provide efficient access to the entire area. One section of the climbing road is shown in the lower right.



The best logging roads should be planned for areas of greatest use. Sections of road near the ends of road systems and in other areas of light use do not have to be as well constructed as main roads that receive heavy use.

On small ownerships, one well-located road with a well-planned skidroad system often provides adequate access to the whole tract. However, property boundaries often prevent fitting logging road systems to topography, and roads cannot be located properly. Under these conditions the erosion-control measures that will be discussed are even more necessary.

Another reason for careful planning is that poorly arranged roads (fig. 5) present an ugly view to other forest users. An orderly road arrangement (fig. 4) presents a more pleasing view. Many problems in public relations might be avoided if more care were used on logging road systems—before, during, and after timber harvest.

Figure 5.—A poorly planned logging-road system. Note the steep roads and haphazard arrangement, resulting in many dead-end roads.

LOGGING-ROAD LOCATION

Roads tentatively located on topographic maps or aerial photographs must be laid out on the land before their final location can be established. It is a good idea to take aerial photographs into the field when locating logging roads so that proposed routes can be followed readily and alternate routes can be chosen if the need arises. Locating roads is easier when two-man teams are used.

In hardwood regions it is easiest to lay out logging roads when trees are leafless. Plastic flagging can be used to mark proposed locations for logging roads. Avoid hanging flagging on objects like rotten branches that may break off in the interval between road layout and construction. Plastic flagging of different colors may be used to distinguish truck roads from skidroads. Road locations may be changed several times before a satisfactory route is found.

To avoid confusion, remove all flagging except that marking final road location before construction begins.

Grade

One of the most important things that determines logging-road location is the grade or steepness of the road. Road grade is commonly expressed in percent. A road with a 10-percent grade, for example, rises or drops 10 feet for every 100 feet of horizontal distance. Road grade can be measured with several instruments; one of the most common and most readily available is the Abney hand level (fig. 6).

Experience has shown that steep roads do not provide efficient access to the stand and that it is difficult to control erosion on them (fig. 7). Slipping and sliding is a greater problem on steep grades. Even a single short section of steep or muddy logging road can restrict the use of several miles of road beyond it. Gentle grades permit timber to be harvested economically without damaging other natural resources. Average downhill skidding speed usually is faster on grades ranging from 5 to 15 percent than on either level or steeper grades.

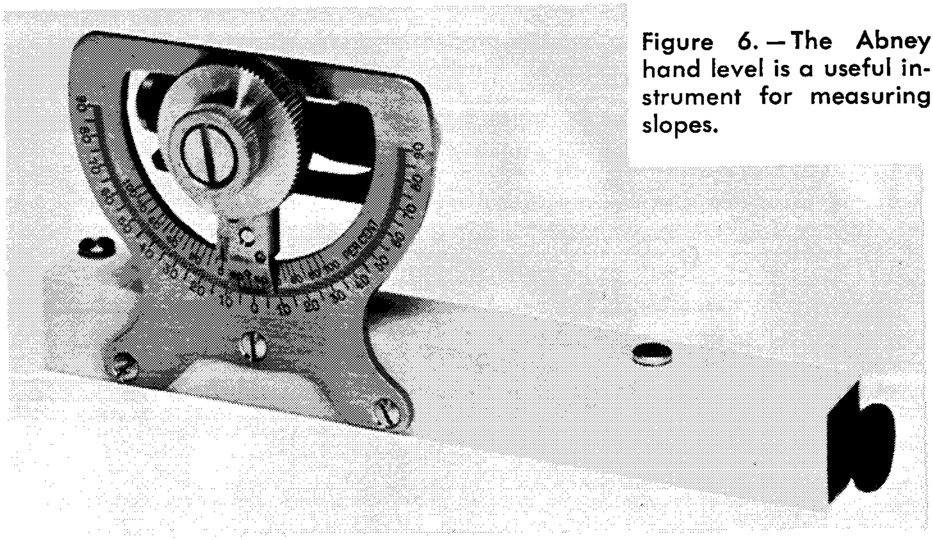


Figure 6. — The Abney hand level is a useful instrument for measuring slopes.

Figure 7. — Well-located and well-constructed roads with gentle grades are required for the efficient operation of modern logging equipment in the rugged Appalachian Mountains. Because these wide roads expose more soil than the narrower roads formerly used, careful erosion control is important.

Roads located on gentle grades provide efficient access for many other uses and can readily be converted into higher class road systems. But long uninterrupted grades should be broken with occasional grade breaks to facilitate drainage. Sometimes sharp curves and switchbacks are unavoidable on steep land; and when they are used, road grades should be reduced to facilitate truck travel. Short sections of logging roads may require higher grades to get around obstacles that cannot be removed economically or avoided by careful planning. If at all possible, steep grades should be restricted to lightly used roads; but, when steep sections are unavoidable, extra measures, such as gravel and additional culverts, are needed to protect the road against erosion.

A minimum grade of 3 percent is desirable to provide adequate drainage on logging roads. When the grade is less than this, water collects in every small depression on the road surface and will not run into drainage structures. Locating contour roads with frequent grade breaks of ± 5 percent to take advantage of terrain and natural drains helps provide proper drainage. Flat areas such as bottomland and broad ridge tops may seem to be attractive road sites because of low initial construction costs, but they usually are poor locations because they often become trough-like and hard to drain. Hillsides usually afford the best locations for logging roads because they permit drainage, less water is encountered on them, and they often provide stronger material for roadbeds (fig. 8). Steepest hillsides should be avoided because here construction costs usually are highest and danger from slips is greatest.

Foresters generally agree that grades on logging roads should seldom exceed 10 percent. Roads laid out on a 10-percent grade often end up being steeper. Experience on the Fernow Experimental Forest has shown that roads laid out on a 10-percent grade will vary between 5 and 15 percent after construction. Constructed roads also vary from proposed locations because they are often built around obstacles like large trees and rocks that could not be avoided during layout. However, changes from carefully selected locations should be done cautiously. Too often roads are built away from original locations simply because initial construc-

Figure 8.—A properly located and properly constructed logging truck road. The road is on a hillside and is well above a stream. The long climbing grade is broken by culverts, and the roadbed contains a high proportion of natural stone.

tion costs appear cheaper, and little thought is given to future uses or possible damage to other resources.

Filter Strips

Experience has shown that a protective strip of absorbent, undisturbed forest soil between logging roads and streams usually prevents muddy road water from reaching streams. This strip of undisturbed land, often called a filter strip, should be wide enough to absorb all the muddy water that runs off road surfaces (fig. 9). Sediment in muddy water is collected on the undisturbed litter and soil, and only clear water enters the streams.

The required filter-strip width varies with the steepness of slope between road and stream, but the effectiveness of filter strips is

Figure 9.—Serious stream pollution occurred when this logging road was located too close to a stream. The filter strip between the road and stream was not wide enough to prevent mud washed off the road from reaching the stream.

increased by obstructions such as logs, slash, depressions, and rocks, which trap sediment. A minimum distance of 100 feet is recommended between logging roads or landings and streams.

Often, steep hillsides will require that logging roads be built even further than 100 feet from streams to keep mud out of them. Sometimes obstructions such as property lines and rock outcrops will force logging roads to be built closer to streams. In these cases, piling slash cleared from road rights-of-way on the slope below overcast soil, and seeding overcast soil to grass, will help minimize stream damage.

Suitable stream-crossing sites are a prime consideration when locating logging roads. Neither deeply cut stream channels nor those in soft, muddy soil can be crossed easily. A narrow place with relatively low banks and firm, rocky soil usually makes the best crossing. Road alinement on approaches to crossing sites must be straight enough so that loaded trucks can cross easily.

DRAINAGE

The usefulness and permanence of logging roads depends to a large extent on how well they are drained. Logging roads must be adequately drained to protect road surfaces from erosion and to prevent mud from spreading over nearby land and into streams. There are many sad examples throughout the Appalachians where uncontrolled water has eroded the surfaces of logging roads, thus destroying their usefulness and necessitating costly repairs (fig. 10). Water also softens and dissolves road material, weakening roadbeds until they will not support equipment. It is especially important to drain forest roads during logging operations, a time when erosion is greatly accelerated because the roads are being continuously disturbed.

Culverts

Several drainage devices have been developed for controlling water flow on logging roads. Culverts are probably most common.

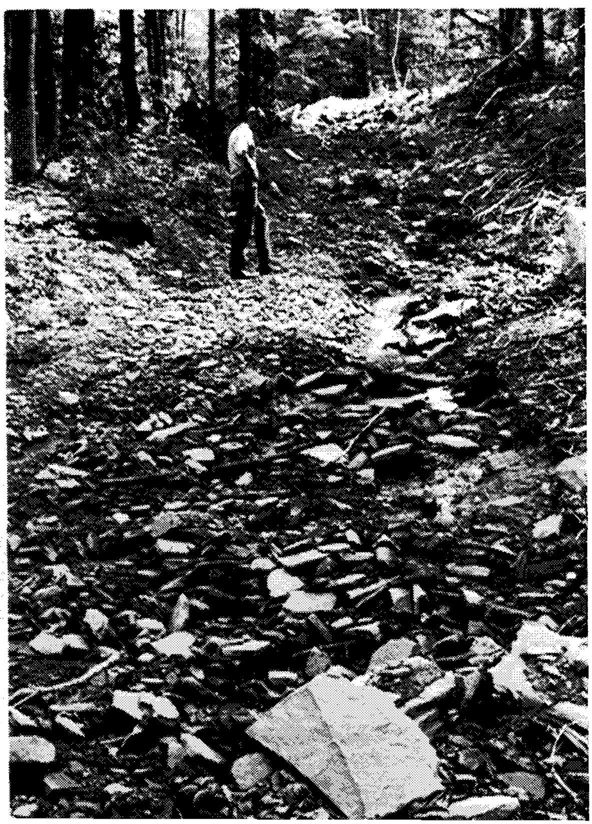


Figure 10.—This logging road is only 2 years old, but uncontrolled water has destroyed its usefulness. Costly road repairs will be required before it can again provide efficient access. Installation of simple drainage structures would have prevented this erosion and would have preserved the road for future use.

Those used on logging roads are usually constructed from metal, lumber, or logs. The minimum effective culvert length for most logging roads is 14 feet; culverts placed in fills must be longer so that they do not become plugged with fill material.

The tabulation below shows culvert diameter required for drainage areas in the southern Appalachian forests. The type I column applies to normal forest soils below 3,000 feet. The type II column is for drainage above 3,000 feet and for shallow soils with frequent rock outcrops at any elevation:

	Area above pipe[1]	
Pipe diameter (inches)	*Type I (acres)*	*Type II (acres)*
12	9	2
15	16	4
18	25	7
21	40	12
24	55	16
30	84	27
36	130	47
42	190	64
48	260	90
54	335	120
60	400	160
66	550	205
72	650	250
78	920	350

[1] Unpublished data, courtesy James E. Douglass, Coweeta Hydrologic Laboratory.

Metal culverts are superior for most drainage needs, except interception of surface runoff. Their initial cost is high, but they last much longer and require less maintenance than wooden culverts or bridges. Serious consideration should be given to using metal culverts on main haul roads, especially in deep fills where periodic replacement of wooden drainage structures is difficult and costly. Installing metal culverts in deep fills is nearly always more satisfactory, and often cheaper, than building wooden bridges.

Culverts used on lower-cost logging truck roads are usually constructed from lumber, logs, or a combination of the two, and are either open-top or closed-top (fig. 11). These two types of wooden culverts, when properly installed and maintained, will adequately drain road-surface runoff, springs, seeps, and other small sources of water.

Open-top culverts (figs. 12 and 13) are most useful for intercepting runoff flowing down road surfaces. However, log-skidding tends to damage and plug up open-top culverts, rendering them

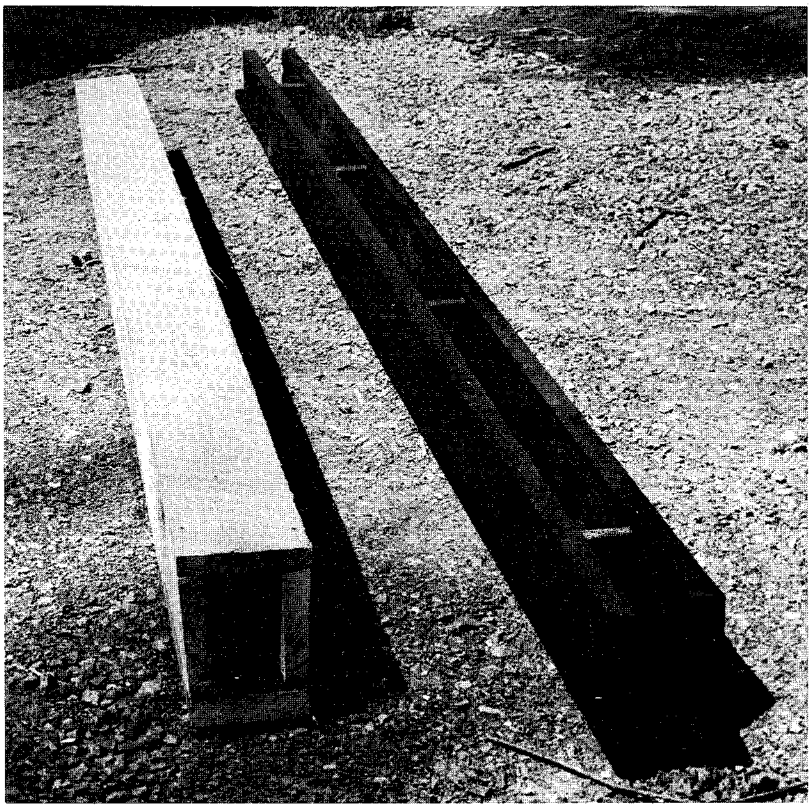


Figure 11.—Closed-top culvert (left) and open-top culvert (right). Both of these culverts were constructed from low-grade 2 x 8 strong hardwood lumber. Larger boards can be used to increase culvert capacity. Culverts should be strongly constructed from hardwood lumber and carefully installed to withstand the pressures exerted by loaded logging trucks.

Figure 12.—This type of open-top culvert does not become plugged with debris as readily as ordinary open-top culverts, and the cost for materials is less. Note the spreaders on the bottom of the logs to prevent them from becoming squeezed together, and the 2-inch spaces between the boards to prevent water from running down wheel tracks and across the culvert. This same principle can be used to construct closed-top culverts.

Figure 13.—Proper installation of culvert shown in figure 12.

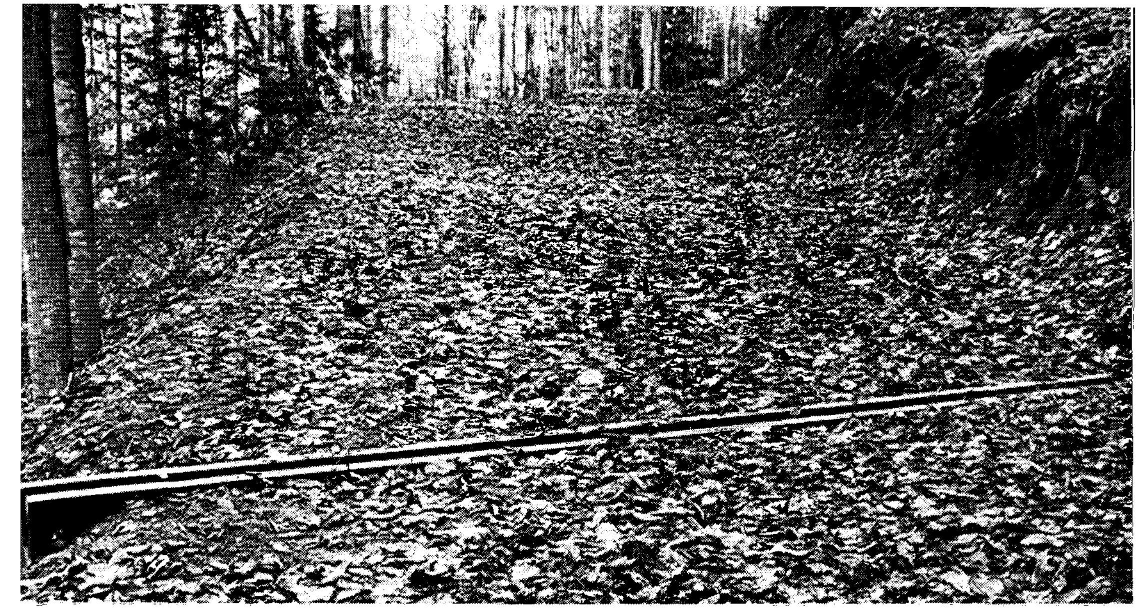


Figure 14.—Installing open-top culverts at about a 30-degree angle downslope enables them to clean themselves and makes them easier to cross with trucks, since both wheels do not cross at the same time. Note the outsloped road surface. A road properly maintained for intermittent travel can have this peaceful undisturbed appearance.

ineffective for erosion control on skidroads. They often become plugged with debris and must be cleaned frequently to be effective. Open-top culverts should be installed at a 30-degree angle downgrade (fig. 14).

Closed-top culverts are placed underneath road surfaces to drain ditches or small streams. They cannot intercept water flowing down road surfaces.

Although ditches are not normally used extensively on most logging roads, short ditches are often used to collect seeps and springs and drain them into culverts. Erosion can be prevented at culvert outlets by installing rocks for the culvert outflow to spill on.

Outsloping

Outsloping is an effective way to remove small quantities of water from logging road surfaces. A properly outsloped road slants slightly from the cut bank to the outside edge of the roadbed (fig. 14). Both the surface and edge of the road must be smoothed out before outsloping can be effective. On logging roads this work is usually done with bulldozers. For safety, roads on steep terrain are often insloped during logging, then outsloped to about 3 percent after logging is completed.

Broad-Based Dips

Broad-based dips (figs. 15 and 16) can be used instead of culverts for cross drainage where no intermittent or permanent streams are present. They are installed after the basic roadbed has been constructed. Broad-based dips, when properly installed, are cheaper to maintain and more permanent than wooden culverts. They can be used effectively on both skidroads and truck roads when road grades do not exceed 10 percent. Broad-based dips do not increase wear on vehicles or reduce hauling speed when properly installed, and they have the added advantage of providing erosion control, even after intensive use, without much additional work. In addition, waterbars do not have to be installed on roads protected with a good system of broad-based dips. Future road

Figure 15.—Properly constructed broad-based drainage dips are cheaper to maintain and more permanent than wooden culverts.

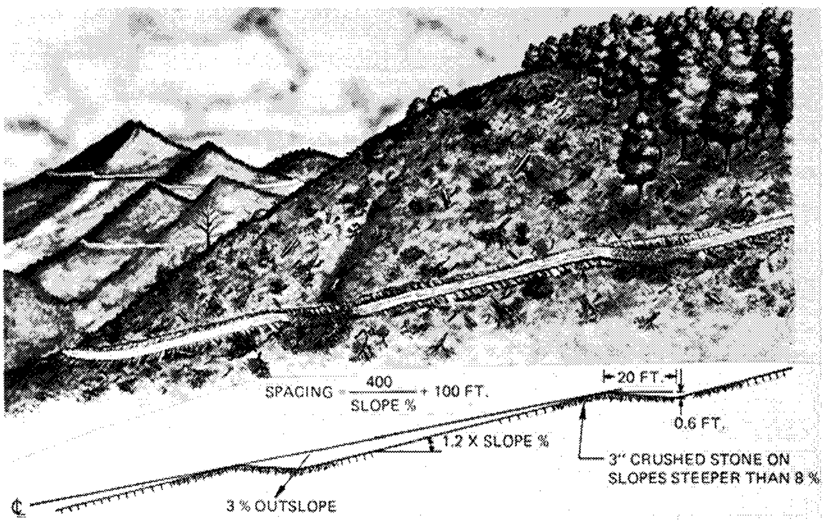


Figure 16.—Diagram showing how to construct a broad-based drainage dip properly. A broad-based drainage dip is constructed by building a 20-foot-long 3-percent reverse grade into the existing roadbed. The bottom of a broad-based drainage dip constructed in a roadbed having a 10-percent grade would be 2.6 feet below the original roadbed.

costs will be low when broad-based dips are used because the roadbed will not be damaged by erosion, waterbars will not have to be smoothed out, nor will rotted wooden culverts have to be replaced.

The biggest disadvantage of broad-based dips is that bulldozer operators must receive some preliminary training before they can construct them properly. Because of their many advantages over conventional wooden culverts, however, broad-based dips should be used more often on logging roads.

Broad-based dips are often made too small. A properly constructed broad-based drainage dip should be large enough so that logging trucks can be parked in it. The spacing formula (fig. 16):

$$\text{Spacing} = \frac{400}{\text{Slope } \%} + 100 \text{ feet}$$

was used to derive the following tabulation, which can be used as a guide to determine spacing for broad-based dips and open-top culverts:

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

Crossing Streams

Bridges or fords should be used to cross streams too large to carry in culverts (fig. 17). Fords can be used where clean water is not a primary consideration and a firm rock base can be established on the streambed and on approaches to the ford. Bridges usually are best for crossing streams too large for culverts, but the final decision regarding the use of fords instead of bridges or culverts often is based on costs.

Figure 17.—A logging-road bridge, suitable for crossing small streams, made from low-grade hardwood lumber and nearby trees. This bridge easily supported a 15-ton bulldozer and will carry loaded logging trucks for several years.

All crossing sites should be selected at right angles to the stream and should not interfere with natural streamflow. Roads should climb away from stream crossings in both directions to prevent high water from running down roads because streams permitted to overflow onto logging roads can wash tremendous quantities of sediment into the streams in very short periods. Open-top culverts or dips on both sides of the crossing sites will divert road runoff into filter strips and prevent dirty water from running directly off roads into streams.

MAINTENANCE

Maintenance of logging roads is often neglected simply because logging with modern power equipment can be done without it. Nevertheless, even the most inexperienced logger knows that timber harvesting is easier and more profitable on smooth, mudfree roads.

Maintenance of logging roads to control erosion and to provide efficient access to stands is basically a problem of water control. The first requirement is a properly functioning drainage system in which culverts, dips, bridges, and outsloping are free to carry away water. The second requirement is to keep the road reasonably free of ruts, curbs, and logging debris that prevent water from flowing freely off road surfaces into drainage structures. All maintenance is reduced if, between the time of construction and heavy use, a few months are allowed for roads to settle.

To function properly, drainage structures must be maintained. They must be inspected frequently and repaired and cleaned whenever damaged or obstructed. Metal culverts require much less maintenance than wooden culverts. When installed on the proper gradient they will be largely self-cleaning and will require only occasional maintenance. An occasional plugged culvert may cause water to wash a gully across the road, but this small amount of erosion will not permanently damage the stream.

Most of the maintenance work required on wooden culverts and bridges can be done with hand tools. Bulldozer tracks are very damaging to wooden bridge surfaces and exposed wooden culverts; damage to these structures may be reduced by covering them with poles or slabs when bulldozers must cross them. Broad-based dips should be reshaped whenever roads are graded. Road surfaces are usually reshaped with bulldozers, which are better than graders to reshape dips. This work is best done a few days after heavy rains, when soil still is soft but not yet too hard and dry to work easily.

Often it helps to "daylight" heavily shaded roads by cutting away overhanging trees because roads exposed to sun and wind dry quickly and require least maintenance. Such treatment is usually restricted to main access roads and roads intensively maintained for wildlife.

Careful location completely eliminates many road-maintenance problems and minimizes others. For instance, experience has shown that roads on sunny south and west slopes dry faster than those on shadier north and east slopes. Roads upslope from streams, springs, or seeps avoid not only the initial expense of many drainage structures but also the frequently recurring expense of cleaning and reshaping surfaces built of soft, slowly draining soil. On the other hand, slumping banks and washouts often create maintenance problems on roads along overly steep slopes.

TRAFFIC REGULATION

Regulating traffic on logging roads during unfavorable weather is an important phase of erosion control. It is impossible to control erosion if unsurfaced roads are used during excessively wet weather. Logging under these conditions destroys drainage structures, plugs up culverts, and causes excessive rutting; thus logging costs are greatly increased (fig. 18). During wet weather the costs of inefficient logging, combined with damage to roads, streams, and wildlife, may exceed the value of timber harvested.

Regulating traffic to minimize the time roads are used intensively helps reduce erosion risks. This is best done by completing logging operations on each area as quickly as practical. When possible, remote areas should be logged first, and measures designed to insure erosion control after logging should be installed

Figure 18.—Severe rutting caused by logging during unfavorable weather. This damage usually occurs during winter and spring months but can occur any time soils become waterlogged.

as the logging operation progresses. Problem areas such as steep roads, wet areas, and highly erodible soils should be logged during the most favorable logging weather. In this way, the most erodible roads can be put to rest before erosion begins.

Sometimes it is not practical to apply this type of common-sense management. For example, loggers might not be able to afford the higher initial road costs that are usually required to operate remote areas first, but hauling forest products for long distances over logging roads during marginal logging weather can unnecessarily rut and otherwise damage soft, wet, thawing roads. Under these restrictive conditions, most loggers will try to operate as close as possible to an all-weather road.

If possible, timber owners and loggers should agree to restrict the actual skidding and hauling of wood products to frozen roads or roads dry enough to permit skidding and hauling without seriously rutting road surfaces. Many mills stockpile logs in the fall and early winter, expecting to shut down logging operations during bad weather. In many cases, stockpiling logs to last an additional month would permit hauling to be limited to good weather without mill shutdowns.

CARE AFTER LOGGING

Immediately after hauling and skidding are completed, additional protection against erosion should be provided. If there are plans to use truck roads intermittently after logging, culverts and bridges can be left intact. Periodic maintenance of drainage structures will permit intermittent use of roads during dry weather and preserve them for future intensive use. If there are no plans to use truck roads after logging, wooden culverts and bridges can be removed to restore natural drainage. Streambanks are disturbed least if bridge abutments are left intact. Removing bridge planking is an effective way to close roads to all but foot traffic.

Sometimes culverts are removed from deep fills for use in other roads or in an attempt to restore natural drainage. However, the cost of removing them can easily exceed their market value and they are usually damaged by machinery during extraction. Also, the disturbance created when culverts are removed often presents an unsightly appearance. Though culverts may eventually become plugged and cause an erosion problem, a greater problem occurs when these high banks of loose fill are undercut by unconfined water and erode for years directly into the streams. Ordinarily, culverts should be left when there is more than 2 feet of fill over them.

When logging is completed, the surfaces of all logging roads should be smoothed, outsloped about 3 percent; and drainage structures should be cleaned. Broad-based dips and culverts, when properly maintained, will provide adequate erosion control on roads where intermittent use is expected after logging. Waterbars should be installed on logging roads that will be closed to vehicle travel after logging and that lack an adequate system of broad-based dips. Waterbars should be installed on the most heavily used skidroads. Logging slash can be lopped and scattered on roads to supplement waterbars where the erosion hazard is high. The following tabulation can be used as a guide to determine waterbar spacing:

Road grade (percent)	*Distance between waterbars (feet)*
2	250
5	135
10	80
15	60
20	45
25	40
30	35

Waterbars, like culverts, should be installed at about a 30-degree angle downslope to help turn water off roads. The downhill end of a waterbar must be open to prevent water from accumulating behind it.

Waterbars can be constructed with hand tools, but bulldozers are commonly used (figs. 19 and 20). When waterbars are con-

Figure 19. — Waterbars being installed on a logging road to be closed to all vehicle traffic.

Figure 20.—A properly constructed waterbar.

structed by machine, it is best to start at the end of the road and work out so that waterbars are not damaged by frequent crossing with machinery.

SEEDING

Grass seeding is an important supplement to mechanical erosion-control structures on logging roads (fig. 21). Seeding is also beneficial in that it provides food for wildlife and improves the appearance of logged areas. However, seeding is usually restricted to areas with high erosion hazards and roads where grass can be maintained for wildlife. In the Appalachian Mountains, most logging roads will revegetate naturally within 2 years if mechanical erosion-control measures are adequate.

One mile of logging road 12 feet wide will contain about 1½ acres of seedable soil. The planting surface should be prepared by disking in 2 tons of lime and 500 pounds of 5-20-10 fertilizer

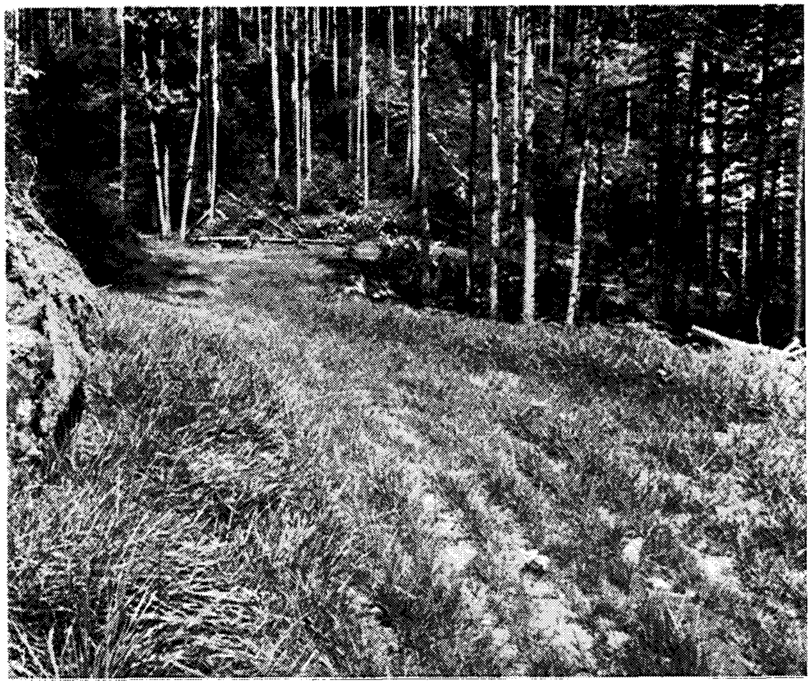


Figure 21.—Seeded logging roads help control erosion.

per acre. A mixture of 2 pounds of ladino clover and 12 pounds of Kentucky fescue per acre has been successful in the Monongahela National Forest in West Virginia, but the best seed mixture and application procedure must be determined for each locality. Service foresters, county agents, or soil conservation personnel can provide landowners with helpful suggestions for most localities.

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