ROADS AND STREAM CROSSINGS

The roads on your property need some maintenance. What do you need to know?

Maintenance of roads on forestlands is a key forest practice. Because dirt or rocked roads exist on most forest ownerships, maintenance work is a common need. Some older or heavily used roads also can benefit from improvements, including better drainage or surfacing.

Maintain active and inactive roads in a manner sufficient to both provide a stable surface and keep the drainage system operating as necessary to protect water quality.

WHAT THIS MEANS:

- Road maintenance is the landowner's responsibility.
- Landowners are required to do the maintenance necessary to protect water quality, not drivability.
- Roads should be inspected to maintain water quality protection.
- Landowners have the ability to control access on their roads through the use of gates and by vacating roads (see page 118).
- Notification of ODF is not required for routine road maintenance activities.

Definitions for forest roads:

- ACTIVE ROADS are currently being used and maintained for hauling forest products.
- Inactive roads have been used at some time since 1972. Roads used for any forest management purpose other than timber hauling are considered inactive. Inactive roads may no longer be drivable due to brush, fill washouts, etc.
- VACATED ROADS have been barricaded. They are self-maintaining and erosion is very unlikely (see page 118).
- ABANDONED ROADS constructed prior to 1972 and not used for forest management since that time are not subject to regulatory authority.
- A STABLE SURFACE is one that remains smooth so that water will not erode the surface and traffic will not lead to water running down ruts. Surfacing material does not break down under traffic, and pumping of mud up through the rock surface does not occur during use (see also durable surfacing and geotextiles later in this chapter).

Facts about roads

Fact #1

Roads are an essential part of forest management.

Fact #2

Of all the ownership features and management activities monitored on forestlands, the largest source of sediment has been roads. Road sediment can be significantly reduced with good road maintenance, improvement and construction practices.

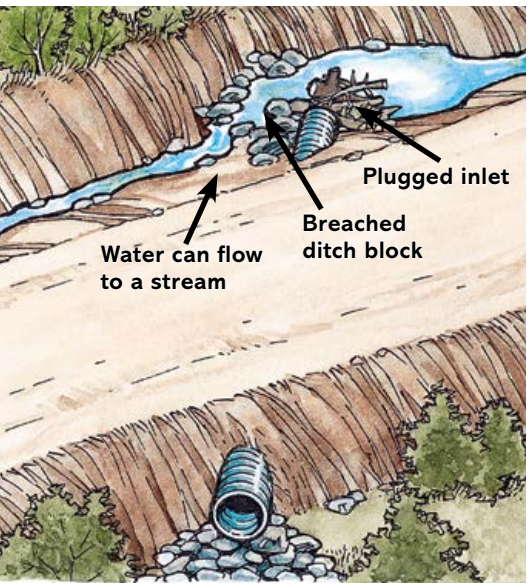
Fact #3

When properly located, designed, built and maintained, roads have a low potential for contributing sediment.

Fact #4

If not well-planned, constructed and maintained, roads located next to streams, on steep slopes or on unstable topography have the potential to produce sediment for a long time.

Not a major sediment problem yet, but when roads become channels for drainage, major sediment pollution can result



This undersized ditch relief culvert resulted in a breached ditch block and sediment flowing directly into the stream. Recommended: 18 inch culverts.

Watch for damaged culverts that need replacement. Repair work should be completed during dry weather.

- AN OPERATING DRAINAGE system means:
  - Water is moved across or under the road before causing erosion.
  - Locations where ditches may be blocked by slides or ravel are identified in advance.
  - Additional ditch relief culverts are added or the road surface changed (inslope, outslope, crown, see page 111) to carry water around the problem.
  - Unanticipated problems are treated as quickly as possible.
  - A functional system, such as undisturbed vegetation, is in place to filter muddy runoff so only minimal sediment enters waters of the state.

Inspect and maintain culvert inlets and outlets, drainage structures and ditches before and during the rainy season as necessary to diminish the likelihood of clogging and the possibility of washouts.

WHAT THIS MEANS:

Someone must be responsible for cleaning all drainage obstructions, including damaged portions of culverts. In-stream large woody debris and beaver dams that do not pose danger to a culvert should not be removed.

Provide effective road surface drainage, such as water bars, surface crowning, constructing sediment barriers, or outsloping, prior to the rainy and runoff seasons.

WHAT THIS MEANS:

Take action to prevent surface runoff from traveling down the road surface. For roads without ditches this means outsloping, removal of unnecessary berms and water barring. For roads with ditches this means crowning and removal of berms.

Soil sloughing off a road cut.

Poor road surface drainage caused this fill slope erosion.

The only berms that should be on the outside of roads are those essential for fill protection. They should seldom exceed 100 feet in length.

What about cut-and-fill slopes?

- In steep terrain, cutslope ravel and slides are common if soils are thick or the rock is fractured.
- Sidecast fill on steep slopes can begin to fail years after initial construction. Tell-tale signs are arc-shaped cracks along the outside edge of the road. An excavator can be used for sidecast pullback, especially if it could move into a creek.
- Debris collects in ditches, and dense vegetation may block water flow. However, light vegetation can stabilize ditches.
- Ditch inspection should be done during storm events when problems are most obvious. Watch for blockage, overflow problems and ditch downcutting.
- Don't delay in cleaning up. Move soil and debris to a location where they will not create additional erosion problems.

- Be aware that these problems may be symptoms, indicating a need for larger ditches or more culverts.
- Reduce erosion by seeding and mulching bare cut-and-fill slopes.
- Ditchline erosion may indicate a need for more or larger culverts or armoring with rock (see ditch gradients, page 112).

Haul all excess material removed by maintenance operations to safe disposal sites and stabilize these sites to prevent erosion. Avoid sidecasting in locations that might become unstable or where erosion will carry materials into a stream.

Roads receive heavy use during logging. Be aware of early signs of damage. Serious damage to road surfaces starts with excess water. Standing water is a sure sign of road-drainage problems. Ruts indicate that road strength is deteriorating.

What about road grading?

- The purpose is to maintain road surfaces – either crown, inslope or outslope (see page 111).
- Grading maintains road surface cross-drain structures.
- Grading corrects road surface damage resulting from vehicle traffic and freeze-thaw cycles that reduce drainage effectiveness.
- Timely road grading and road use restrictions during wet periods can protect drainage on unimproved roads.
- Grade road surfaces only as often as necessary to maintain a stable running surface and adequate surface drainage.

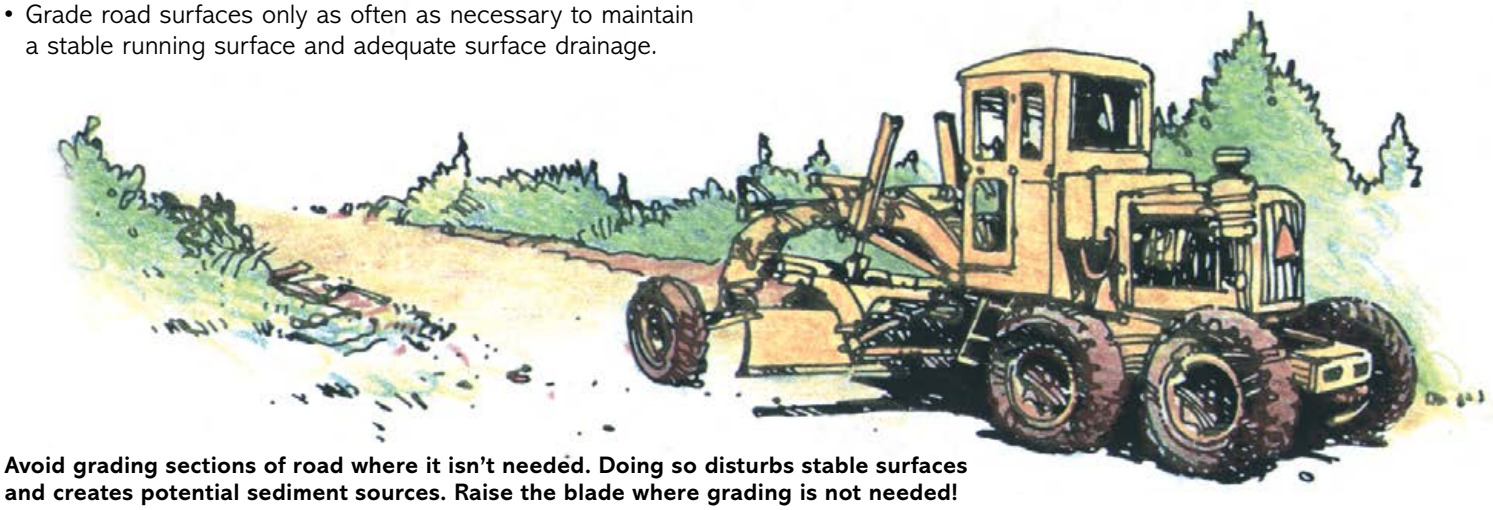
Grader damage to inside ditch toe slopes exposes an easily erodible surface and is a source of sediment.

Slow, controlled grader operation is key to reducing culvert inlet and outlet damage. Reduce damage by keeping graders on the road running surface. Never sidecast gravel toward culvert inlets or outlets.

What are precautions for road grading?

- Grading should be done when roads are neither dusty nor muddy. Moist roads are more easily shaped and compacted by grading machinery.
- Watch for steep sections or curves where added wear and rutting takes place.
- Avoid cutting the toe of cut slopes when grading roads, pulling ditches or plowing snow.

When applying road oil or other surface stabilizing materials, plan and conduct the operation in a manner that prevents these materials from entering waters of the state.



Avoid grading sections of road where it isn't needed. Doing so disturbs stable surfaces and creates potential sediment sources. Raise the blade where grading is not needed!

WHAT THIS MEANS:

Waste oil is prohibited on forest roads. Other materials need to be applied so they do not enter or wash into streams, lakes and wetlands.

In the northwest and southwest Oregon regions, maintain and repair active and inactive roads as needed to minimize damage to waters of the state. This may include maintenance and repair of all portions of the road prism during and after intense winter storms, as safety, weather, soil moisture and other considerations permit.

WHAT THIS MEANS:

Landowners are required to take whatever reasonable action is necessary to prevent material from entering waters of the state. Road repair includes replacing or adding culverts, sidecast pullback and removing of debris in the road.

Place material removed from ditches in a stable location.

WHAT THIS MEANS:

Soils and debris removed from ditches during grading and/or cleaning should be placed in a location that does not cause slope instability or where it will wash back into the ditch.

Remove berms on the edges of roads or provide effective drainage through berms, except for those berms intentionally designed to protect road fills.

What do you need to know about road drainage?

Whether old or new, forest roads need effective drainage to remain functional and avoid erosion and sedimentation problems. In addition to better maintenance, road drainage improvements may be needed on roads that show such problems.

Provide a drainage system using grade reversals, surface sloping, ditches, culverts and/or water bars as necessary to control and disperse surface water to minimize erosion of the road.

WHAT THIS MEANS:

Roadway surfaces are normally crowned or sloped to remove surface water. Other key features include road grade changes, adequate ditches and ditch relief culverts that control drainage and ensure water quality.

Most landowners, at least in western Oregon, prefer to use crowned roads with ditches and cross-drain culverts.

Outsloping is most suitable for low-service roads with a gentle grade (less than 7 percent) and where rutting is prevented by more frequent smoothing (grading) of the surface.

Provide effective cross drainage on all roads, including temporary roads.

WHAT THIS MEANS:

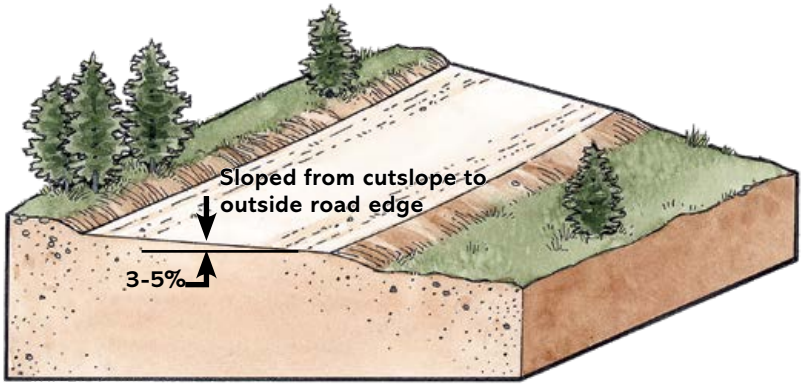
Even for temporary or inactive roads, drainage must be provided that gives the same level of water quality protection as required of active roads.

Drain uncompleted roads, which are subject to erosion.

WHAT THIS MEANS:

When work is stopped on road improvements or new construction and there is an erosion potential, cross drainage with culverts, water bars, dips or other means is required (see following pages for details).

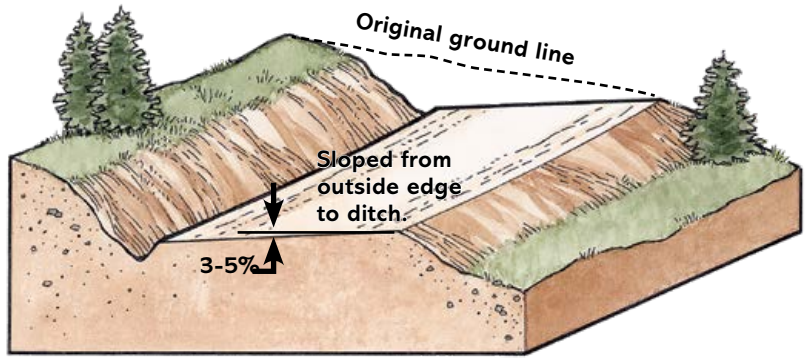
OUTSLOPE ROAD



OUTSLOPE ROAD IS USED WHEN:

- the road grade is gentle or flat (≤7 percent)
- the ditch or cutslope is unstable
- the surface can be kept smooth
- a road is vacated
- rutting can be controlled
- road use is seasonal and traffic is light

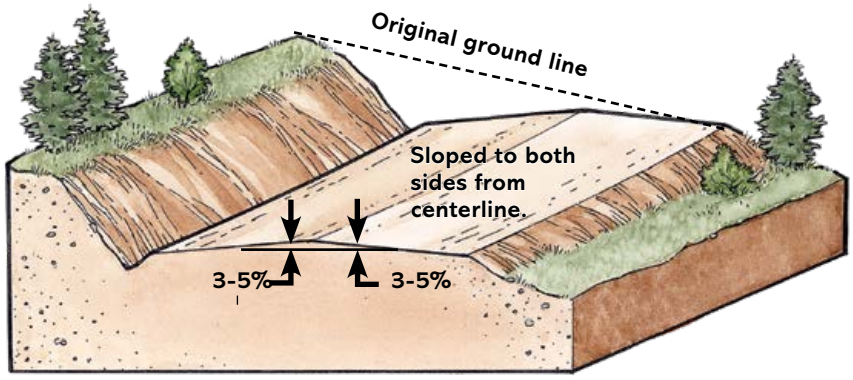
INSLOPE ROADS



INSLOPE ROAD IS USED WHEN:

- the road grade is steep (>7 percent)
- surface drainage is carried to a ditch or surface drain
- an outslope causes fill erosion
- an outslope is ineffective due to ruts
- slippery or icy road conditions are prevalent

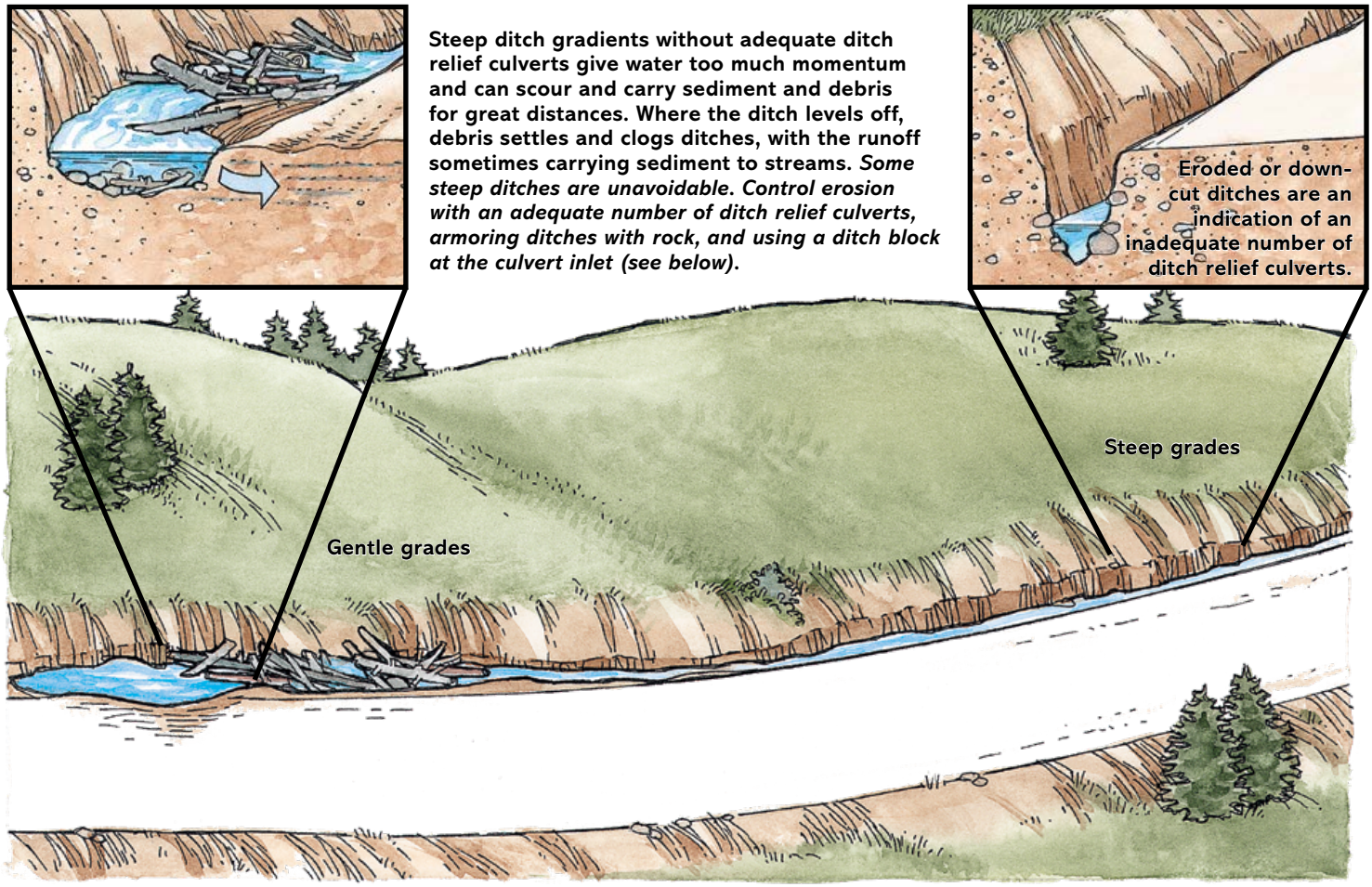
CROWN ROADS

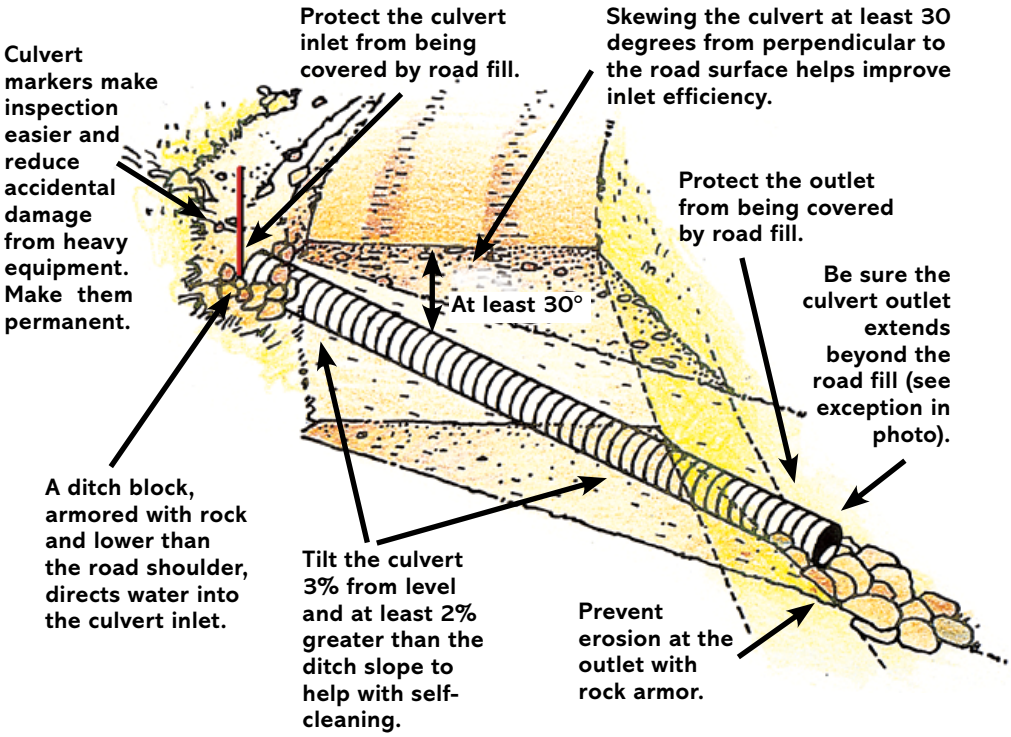


CROWN ROAD IS USED WHEN:

- two traffic lanes are needed
- there is a single lane on steep grade
- regular maintenance of ditches, crown and cross drains is possible
- slippery or icy road conditions are prevalent
- the road grade is flat (crown fill)

What you need to know about ditch grades: TOO STEEP OR NOT STEEP ENOUGH?



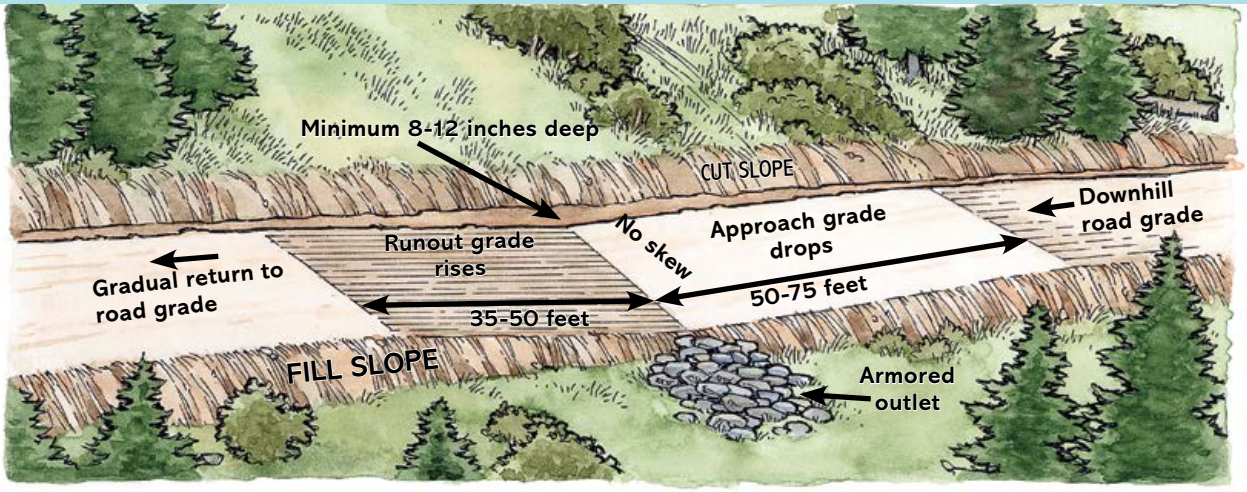


What are ditch relief culverts?

- They move water from the ditch on the uphill side of the road under the road, releasing it onto a stable area on the downhill side.
- They prevent water from crossing the road surface and softening the roadbed.

Eighteen-inch-diameter culverts are recommended where soil and debris plugging is a concern.

It may not always be possible to have the culvert extend beyond the fill. For steep fills, a half-round or flume should carry water beyond the fill.

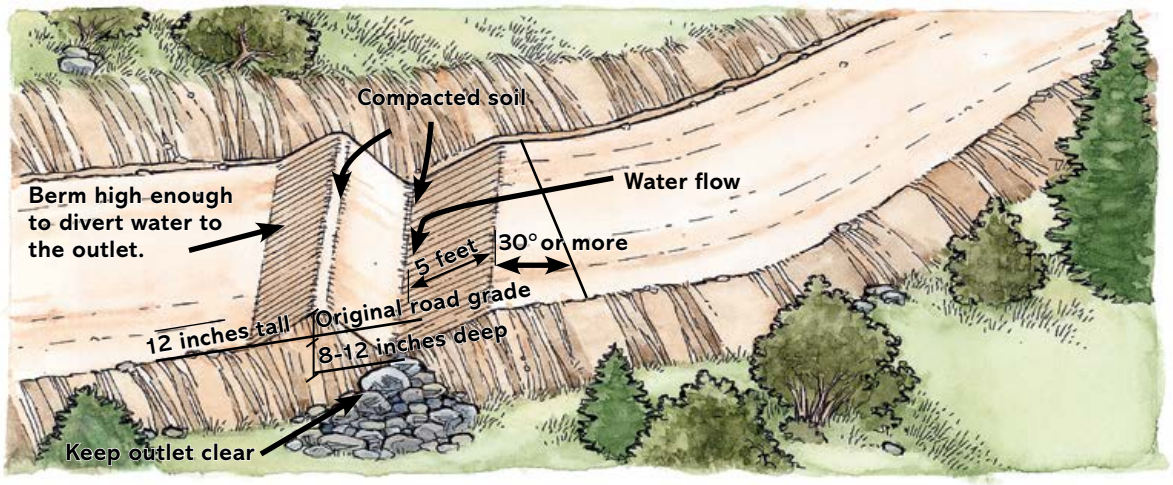


The drain dip bottom is sloped to carry water from the inside to the outside of the road surface, onto natural ground.

What are drain dips?

Gentle rolls in the road surface that are sloped to carry water to the outside, onto natural ground.

- Their approach, depth and runout features provide drainage without being a driving hazard.
- They can be used on ditched or unditched roads.
- They are effective on roads with gentle grades.
- They may be difficult to construct on steeper grades, where ditch relief culverts are preferred.
- Some dimensions and locations may be difficult for log trucks to negotiate.



What are water bars?

Small earth dams or humps built into the road surface, which divert road surface water to where it will not cause erosion.

- They are used on inactive roads and skidtrails.
- They are best constructed with mechanical equipment (better excavation and compaction), but can be built with a shovel.
- Basic spacing guidelines use soil type and slope (see Table 6-1), but other local factors such as road dimensions, aspect (compass direction the hillside faces) and climate also should be considered.

Table 6-1
Water Bar Spacing (feet) Guidelines

Slope	Erodible Soil (sand, ash, etc.)	More Stable Soil
2-5%	400	600
6-12%	200	300
13-18%	100	200
Over 19%	50	150

You are responsible for road drainage near streams.

Locate dips, water bars or cross drainage culverts above and away from stream crossings so that road drainage water is filtered before entering water.

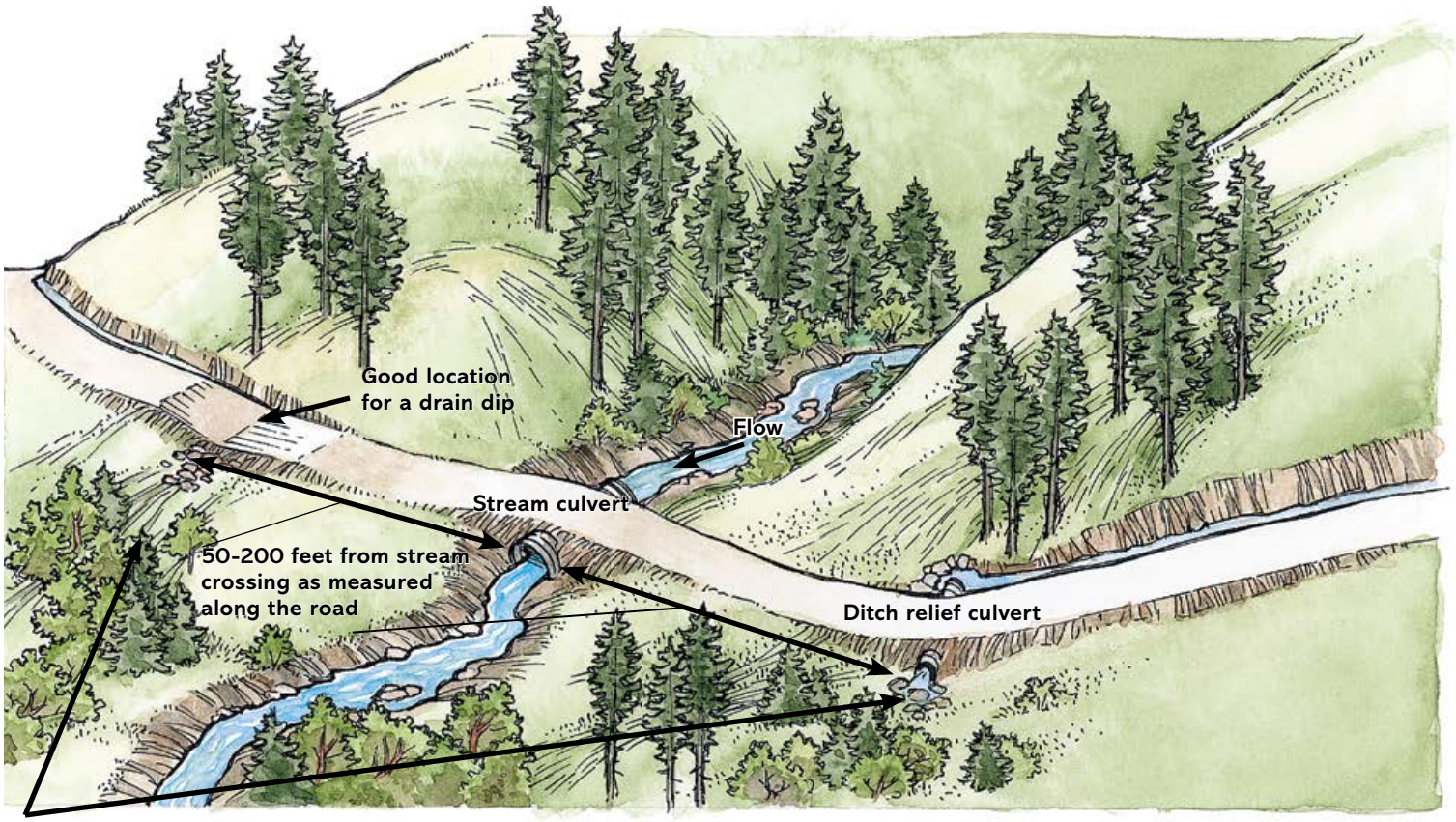
fpa

WHAT THIS MEANS:

Install dips, water bars or cross-drain culverts above and away from stream crossings so road drainage water may be filtered through ground vegetation before entering the stream.

Drainage water should be directed onto undisturbed, vegetated soil.

Route ditch drainage through a filter of vegetation and undisturbed soil so sediment can be removed before water reaches the stream.



Ditch drainage should be directed into vegetation and undisturbed soil filter, and not allowed to continue flowing down the ditch and into the stream.

Cross streams at right angles to the main channel. Road grades that drop into the stream can increase sediment in the stream. Grades that dip very gently or not at all toward the stream deliver less sediment. Never allow road ditches or ditch relief culvert drainage to flow into a stream. Culvert drainage and road ditches should always be directed through a vegetation filter before reaching the stream. Be aware of the risk of causing slope failure on steep slopes if water is concentrated into very steep areas or old landslides where water hasn't been flowing.

Hay bales or small slash windrows can reduce stream sedimentation. They slow surface water and trap sediment.

Road surfacing can double the cost of a road. However, gravel roads can provide all-weather access, reduce road maintenance costs and protect water quality by covering the soil with a weather-resistant surface.

What about springs or seeps near roads?

Provide drainage when roads cross or expose springs, seeps or wet areas.

WHAT THIS MEANS:

- This applies to all hillslope wet areas, regardless of whether they were known before construction.
- Road fill should not be placed on top of springs. In areas with high groundwater, it may be necessary to use French drains in the ditch area, or use a free-draining fill.
- Where cut slopes or road surfaces expose flowing water, roads must be graded and cross-drained to remove this water before ditch cutting occurs.

Clear channels and ditches of slash and other construction debris that can interfere with effective roadway drainage.

fpa

WHAT THIS MEANS:

Road work and use can generate debris that can impact both natural and constructed drainages. All floatable material should be removed from ditches for a minimum of at least 25 feet above ditch relief culvert inlets.

What's needed when a road is used during wet weather?

Traffic on forest roads during wet weather can generate fine sediment that, with surface runoff, may reach and pollute streams. Durable surfacing or other effective measures are needed to avoid these problems on roads used for log hauling during wet weather. In some situations, if such pollution occurs, operators are required to cease active road use.

WHAT THIS MEANS:

Wet weather is any period when rain or snowmelt normally occurs. In western Oregon this period typically extends from October through April. In eastern Oregon, this includes wet periods from both snowmelt and individual rainstorms.

Wet-weather road use can be a source of water turbidity and fine sediment to streams from muddy runoff water. Turbidity refers to the very small, dissolved materials that remain suspended in water and prevent light from penetrating. High turbidity levels can cause stress in fish, affect fish feeding rates, impair their homing instincts and reduce growth rates. Sediment can smother fish eggs (redds) and affect aquatic insect life.

A durable surface such as rock is needed for wet weather use of road segments that drain to streams. Not just any rock will do – avoid round or weak rock. Instead, use hard, fractured rock with sharp corners, a mix of sizes and some fines (small pieces). Fractured rock packs, better and the fines help seal the surface from water, which make it resistant under heavy traffic. Sometimes adequate rock, called pit run, can be dug directly from quarries. In other cases, rock should be crushed, sized and mixed to provide the needed quality. Rock surfacing depth should be thick enough to prevent serious rutting.

It is best to use quality rock near stream crossings, because rock quality can affect water quality. Use of quality aggregate can reduce sediment and water turbidity during wet weather road use (see box on previous page).

Durable rock surface on a log hauling road during heavy rain. Notice that the water in the ditch is clean.

What is durable surfacing?

Durable material resists deep rutting or the development of a layer of mud on the road surface.

It may be quarry aggregate or pit run rock (see page 115). It does not include crushed sandstone, decomposed granite or similar material. Durable rock has a small percentage of fines (very small pieces). Too many fines can wash into streams (see sidebar on Page 115).

- Rock is best applied in layers. A base layer of hard, 3-to-12 inch angular rock with no fines provides for good drainage. A surface layer of hard, 3/4" and less angular rock with some fines

Where Snow and Freezing Weather Occur

Snow berm breaks allow for drainage during snowmelt without damaging the road surface. They also serve as escape corridors for wildlife.

During snowmelt periods, water is directed through the snow berm break.

WHAT'S THE GOAL?

Ensuring that the road surface is well-frozen or otherwise stable during use, and that it will drain properly during thaw periods. This helps protect both the road and water quality.

REASONS FOR SNOW PLOWING:

- It enhances deep-freezing of the road surface.
- It keeps water off the road during melt periods.

WHEN PLOWING SNOW, TAKE CARE WITH SNOW BERMS:

- Provide breaks in snow berms to allow for road drainage.
- Locate breaks above a vegetated filter area and away from streams.
- Locate breaks away from steep fills, headwalls or landslide areas.
- Near streams, plow a snow berm along the road edge to keep runoff from flowing directly the into stream.

BE PREPARED TO SUSPEND ROAD USE:

- when thawing occurs and traffic damages the road surface
- at the sign of surface rutting
- when there is potential for road runoff to reach streams

to provide cohesion and stability. Rock must be thick enough to prevent pumping of mud up through the rock. Geotextiles can minimize pumping and reduce the need for a thick rock layer (see below).

- Even durable surfacing may develop ruts that channel runoff and sediment, requiring grading or resurfacing.

Under what conditions must road use cease?

Operators must cease active road use where runoff from a deeply rutted or muddy surface causes a visible increase in turbidity of a Type F, SSBT or D stream. There is also cause for concern when such an increase in turbidity is seen in a Type N stream, as this could reflect inadequate road maintenance or eventually result in sediment reaching a Type F, SSBT or D stream.

Geotextiles are used to reinforce subgrades by spreading the load across a larger area. This reduces the chance of settling and failure. It also allows road construction across wet areas, reducing the need to remove unsuitable roadbed material.

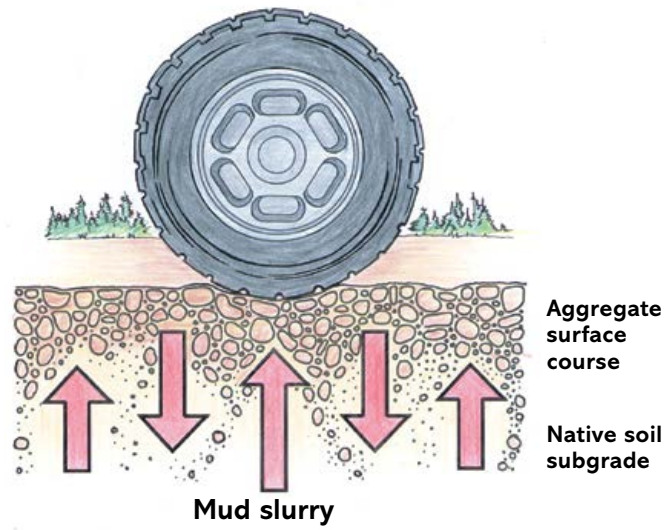
What are geotextiles and what are their uses?

Geotextiles are synthetic, permeable fabrics used to reduce rutting, stabilize the ground and increase the load-carrying capacity of both paved and unpaved roads.

They are used to separate rock surfacing materials from subgrade soils while allowing for water passage.

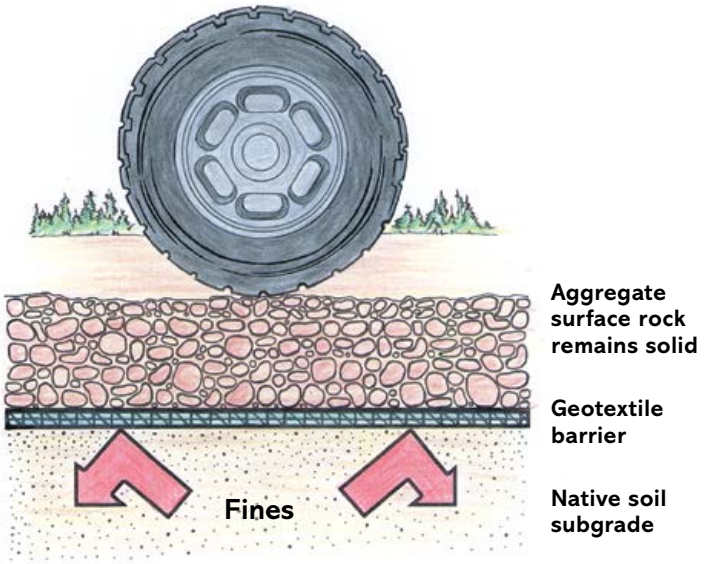
Geotextiles can reduce the amount of rock surfacing needed and reduce overall road costs.

Geotextiles can keep weak or wet subgrade soils from moving into the road base rock layer, reducing its weight-carrying effectiveness.



ROADWAY WITHOUT GEOTEXTILE

Mud slurry mixes with surface aggregate. Mud may pump up through the rock surface.



ROADWAY WITH GEOTEXTILE

Fines are stopped by geotextile.

What about road closures?

Forest roads remain part of the landscape long after harvest, site preparation and reforestation are completed. If access is not needed after successful reforestation, roads may be closed temporarily or permanently, or vacated. A plan for road closure should always consider local wildlife suppression concerns.

Temporary road closure is easiest. Permanent closure, or vacating a road, involves specific actions described below.

Consider gates, barricades or signs to limit use of roads during wet periods. Such barriers also can be effective for reducing the chance of human-caused fires, vandalism and other illegal activities. Develop a plan for allowing timely access to emergency responders (e.g., ODF, sheriff).

How are temporary road closures used?

During wet periods, if road use is likely to damage the road drainage structures. Temporary closures also are useful when roads are not needed for extended periods.

Upon completion of an operation, ensure that drainage structures are fully functional. The road surface should be crowned, outsloped, insloped or water-barred. Remove berms from the outside edge where runoff is channeled.

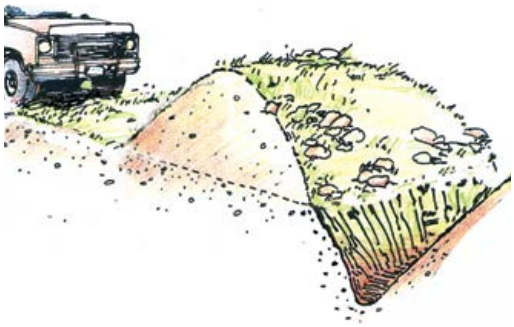
How do you vacate a road?

Road vacating is the unbuilding or dismantling of a road to provide a stable, revegetated condition. Vacating a road is more than just blocking the road from traffic. It can solve costly road maintenance requirements, but it requires the most preparation.

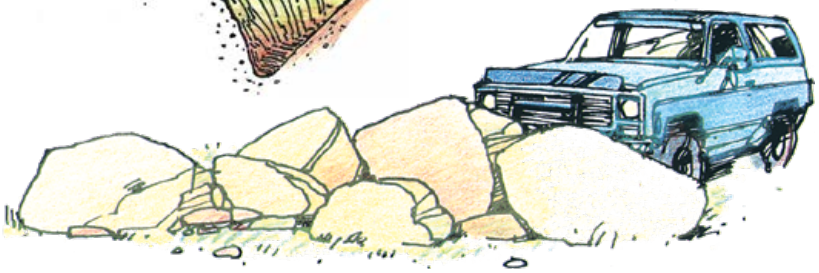
Vacated roads must provide adequate drainage and stability without further maintenance, which requires measures such as traffic barriers, frequent cross ditches, and scarification and/or seeding of exposed soils.

Traffic control is an effective way to reduce road maintenance costs and provide protection of other forest resources. Traffic control can include full road closure, temporary or seasonal closure, or road restricted to only light use. Whichever traffic control option is selected, all require regular maintenance inspections.

Alternatives to gates include large berms or trenches, logs, stumps or large boulders. Never use a suspended cable to block a road, as it can be difficult to see and may seriously injure an unsuspecting visitor. Liability in such cases lies with the landowner, even if signs are displayed.



A tank trap must be deep enough and in a location where vehicles cannot go around. Warning signs for the trap should be displayed well in advance, preferably at a turnaround area.



It may be necessary to physically block road access. Gates provide temporary closure along with quick access if needed. To prevent vandalism, gates and other barriers must be well anchored.

When vacating a road, removal of all stream crossing culverts and associated fill material is required. Non-drivable water bars (cross-ditches) should be installed to drain the road surface. Space water bars more closely, because with time they may fill with sediment.

Remove all steep sidecast fill. Place removed fill and debris away from streams and off steep slopes or old slide areas.

Restore all stream crossings to a stable, self-maintaining condition. This includes reseeding both the road surface and cut-and-fill slopes.

When should vacating a road be considered?

Long-term needs for access should be carefully considered before vacating a road, because the costs of reconstruction can be substantial. However, it may be desirable to vacate a road:

- when the road no longer serves a useful purpose
- when there's a need to eliminate or discourage access
- when you need to reduce erosion and sedimentation from a poorly located road
- when you need to correct unstable road cuts and fills

Where is road vacating used?

It may be necessary to vacate only some road segments, such as recontouring a road junction and its initial stretch of road. Other segments may be stable and can be revegetated as is.

To vacate a forest road, landowners shall effectively block the road to prevent continued use by vehicle traffic and shall take all reasonable actions to leave the road in a condition where road-related damage to waters of the state is unlikely.

Road segment before vacating.

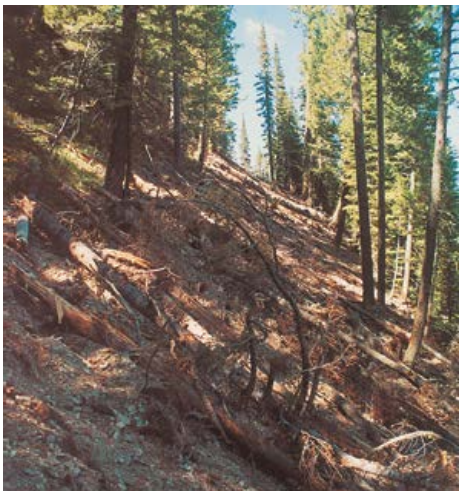
Excavator dismantling the road corridor.

What this means:

In addition to preventing traffic, culverts that might carry flow (including all stream crossing culverts) should be removed and unstable sidecast should be pulled back.

Reasonable actions to vacate a forest road may include:

- removal of stream crossing fills
- pullback of fills on steep slopes
- frequent cross ditching
- vegetative stabilization



Vacated road segment with large wood in place before reseeding the surface with grass.

What about rock pits and quarries?

Development, use and abandonment of rock pits or quarries located on forestland and used for forest management shall be conducted using practices which maintain stable slopes and protect water quality. Rock pits for non-forest management uses are regulated by the Department of Geology and Mineral Industries.

Don't locate quarry sites in channels.

When using rock pits or quarries, prevent overburden, solid wastes, or petroleum products from entering waters of the state.

Stabilize banks, headwalls, and other surfaces of quarries and rock pits to prevent surface erosion or landslides.

When a quarry or rock pit is inactive or vacated, stabilize banks, headwalls, and other surfaces and remove from the forest all petroleum-related waste material associated with the operation and dispose of all other debris so that those materials do not enter waters of the state.

For other information sources, see the Appendix, pages 197-198.

Do you need help?

A consulting forester, road engineer or geotechnical specialist could help with a difficult or complex situation. Getting such help could avoid not only a violation, but also damage to your property and road investments.

You want to build or reconstruct a forest road. What do you need to know?

When do you need a written plan before starting road construction?

A written plan is needed for road construction that involves:

- a risk of material entering water from direct placement, rolling, falling, blasting, landslide or debris flows
- conducting machine activity in Type F, SSBT or D streams, lakes or significant wetlands
- operations in an RMA
- a stream crossing with a fill more than 15 feet deep
- placement of logs or boulders in a channel for stream enhancement
- a high landslide hazard location (see page 52)

What else do you need to know about road location?

Locate roads where you can minimize the risk of materials entering water and where you can minimize disturbance to channels, lakes, wetlands and floodplains.

Avoid locating roads on steep slopes, slide areas or high landslide hazard locations (page 52) and in wetlands, RMAs, channels or floodplains if alternatives exist. Minimize the number of stream crossings.

Reduce the duplication of roads by making use of existing roads where practical. Investigate agreements to use or tie into roads on adjacent ownerships before constructing new roads.

WHAT THIS MEANS:

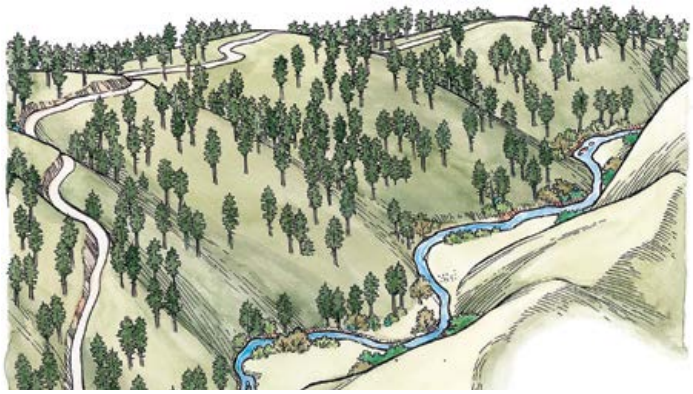
Your road location is very important. Roads should be avoided in certain locations. Reduce the amount of road in the following locations to the maximum extent possible:

- RMAs
- parallel and next to a stream of any size
- on a high landslide hazard location, especially when rock is fractured
- on steep, granitic slopes or other high gully hazard areas
- across the toe of old landslide deposits

In a few locations roads cannot be constructed without causing significant impacts to streams and water quality. One example is a road constructed in the bottom of a very narrow canyon. This cannot be done without filling in part of the stream channel. Another example is some slopes that are too unstable for safe road construction. Road construction in these and other critical locations is not allowed.

UNACCEPTABLE OPTION. Roads built or reconstructed next to a stream channel with multiple crossings are not allowed. Note: Many older roads and highways are in such locations.

ACCEPTABLE OPTION, if no other alternative. Road built up on the 45 percent sideslopes. This option might be more difficult to build, but it is better.



BEST OPTION. Build road on ridge top and plan for cable harvesting.

What about road construction on steep slopes?

Rapidly moving landslides can be triggered when road fill or sidecast material is pushed or placed onto steep slopes below the road. Movement may occur with the next major storm or it may not occur for decades. For this reason, always end-haul excavated material if there is a risk of a landslide reaching a stream, a home or a paved public road (see illustrations, page 53).

Design and construct roads to limit the alteration of natural slopes and drainage patterns to those that will safely accommodate the anticipated use of the road and will protect waters of the state.

WHAT THIS MEANS:

If the road you want to build is on gentle terrain and away from streams, the design and reconnaissance is less detailed. But if the road you want to build is on steep slopes or crosses Type F or SSBT streams, the design is more complicated. You've got to know:

- how to minimize disturbing erodible slopes next to stream channels
- how to avoid damage to side channels
- how to allow for large flood flows without crossing structures washing out
- how to pass juvenile trout and salmon upstream and downstream at crossings
- how to allow fish access to side channels
- how steep grades (more than 20 percent) can create drainage, traction and safety problems; assist vehicles may be needed

Do not concentrate road drainage water into headwalls or high landslide hazard locations.

WHAT THIS MEANS:

If possible, place cross drain culverts away from high landslide hazard locations. If this is not possible, use numerous cross drain culverts to handle runoff.

Design roads no wider than necessary to accommodate anticipated use.

WHAT THIS MEANS

Narrow road widths reduce erosion, protect water quality and can reduce costs. Use the preferred width in Table 6-2 when possible. To allow for two-way traffic, turnouts are required in narrow roads in strategic and stable locations.

When constructing a full-bench road, the entire road surface is excavated in the hill. The excavated material is end-hauled, meaning the material is removed by truck to an area needing fill or to a stable disposal area.

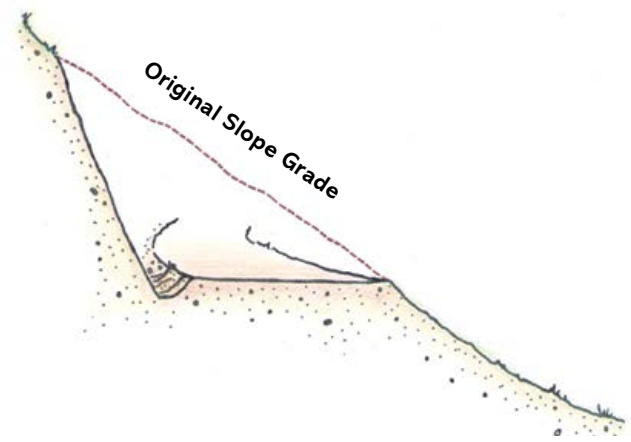


Table 6-2 General Guidelines for Road Widths

Road Use	Maximum Width	Preferred Width
Minor spur & temporary	18 feet	12 feet
Collector road	22 feet	16 feet
Mainline haul road	30 feet	24 feet

When constructing a full-bench road, the entire road surface is excavated into the hill. The excavated material is end-hauled, meaning the material is removed by truck to an area needing fill or to a stable disposal area.

Use variable grades and alignments to avoid less suitable terrain so that the road prism (its cross section) is the least disturbing to protected resources, avoids steep sidehill areas, wet areas and potentially unstable areas as safe, effective vehicle use requirements allow.

End-haul excess material from steep slopes or high landslide hazard locations.

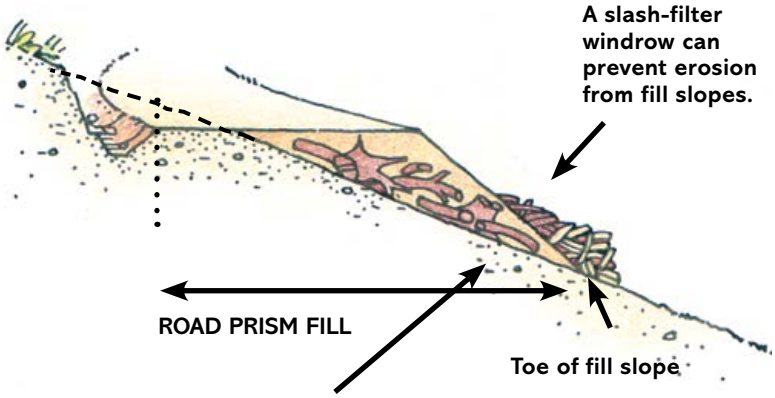
WHAT THIS MEANS:

Roads built with sidecast construction across steep slopes can trigger landslides. If there is a risk of a landslide reaching a stream, home or paved public road, the road must be full-bench constructed and excavated material must be end-hauled.

Design cut-and-fill slopes to minimize the risk of landslides.

Cut-and-fill construction is common for gentle terrain. Soil is taken from cuts and pushed or "drifted" to where fill is needed to build up flat areas or cover culverts. Never let sidecast or waste material enter streams, and never place it on unstable areas where it might erode or slide.

Slash-filter windrows are compacted logging slash, installed along the base of fill slopes during road construction. Built by excavators, these 3-by-3 foot barriers are very effective at slowing surface runoff and keeping sediment from entering streams.



Always avoid mixing stumps and other vegetative debris into the road fill. Over time, it can lead to road slumping and failure.

WHAT THIS MEANS:

Select slope angles that are unlikely to result in landslides. Consult a geotechnical specialist for roads needed in high landslide hazard locations.

Stabilize road fills as needed to prevent fill failure and later damage to waters of the state-using compaction, buttressing, subsurface drainage, rock facing or other means.

How do you dispose of road waste materials?

During road construction, don't put debris, sidecast, waste and other excess materials in locations where they may enter waters of the state during or after construction.

WHAT THIS MEANS:

Never place end-haul material, clearing and grubbing debris, or other soil or rock where it could cause slope instability or be eroded by a flood.

Select stable areas for disposal of end-haul materials. Prevent overloading areas, which may become unstable from additional material loading.

WHAT THIS MEANS:

You must submit a written plan for waste disposal areas, which have a risk of slope failure and also a risk of material from that failure entering water.

The weight of waste fill can trigger landslides, even when placed on a gentle sloping bench. Before placing waste on a midslope bench, or a slope steeper than 50 percent, consult a geotechnical specialist. Be cautious using midslope areas that already contain waste. Additional waste can lead to a landslide.

Stabilize exposed material that may be unstable or erodible by seeding, mulching, riprapping, leaving light slashing, pull-back or other means.

You want to build or improve a stream crossing. What do you need to know?

Forest roads that cross or come close to water can affect:

- water quality
- aquatic habitats
- fish migration
- stream and wetland characteristics
- riparian habitats

Stream crossing structures include culverts (both closed and bottomless arch), bridges and fords. Each is designed to allow water to pass the structure without causing erosion and provide a safe vehicle crossing.

Some crossings require a written plan for review by ODF. On Type F and SSBT streams, structure designs must allow juvenile and adult fish to migrate upstream and downstream.

What does the choice of stream crossing depend on?

STREAM SIZE: Bridges are best for streams more than 10 feet wide and those with high gradients.

WHETHER IT'S A TYPE F OR SSBT STREAM: Bottomless arch culverts and bridges protect the natural streambed with less impact on fish.

CONSTRUCTION AND MAINTENANCE COSTS: Structures ranked in order of increasing cost are:

- ford
- round culvert
- squash culvert
- bottomless arch culvert
- bridge

FUTURE YEARS OF USE: Culverts provide year-round access with a rock surface. However, a ford used once in the length of a forest rotation has less impact than a permanent stream crossing.

SOIL FOUNDATION CONDITIONS: Bedrock crossings may require bottomless arch culverts, bridges or fords.

AVAILABLE EQUIPMENT AND MATERIALS: Culvert installation can include the use of a dozer, backhoe or excavator, portable compactor, bedding gravel, armoring material, culvert outlet downspout and sediment filter.

Bridges sometimes require cranes, concrete truck access for abutments, piledrivers, and high-service-level roads for steel or pre-stressed concrete delivery.

Fords require armoring of approaches and stream bottom, and possibly geotextile and excavation equipment.

OTHER REQUIREMENTS: Some crossings, especially bridges, require qualified engineers. Hydrologic and fisheries needs may require additional consultation. Written plans and review by ODF may be needed.

Are written plans needed for road building projects across a stream or wetland, or near a lake?

Yes. Written plans must be submitted to ODF before:

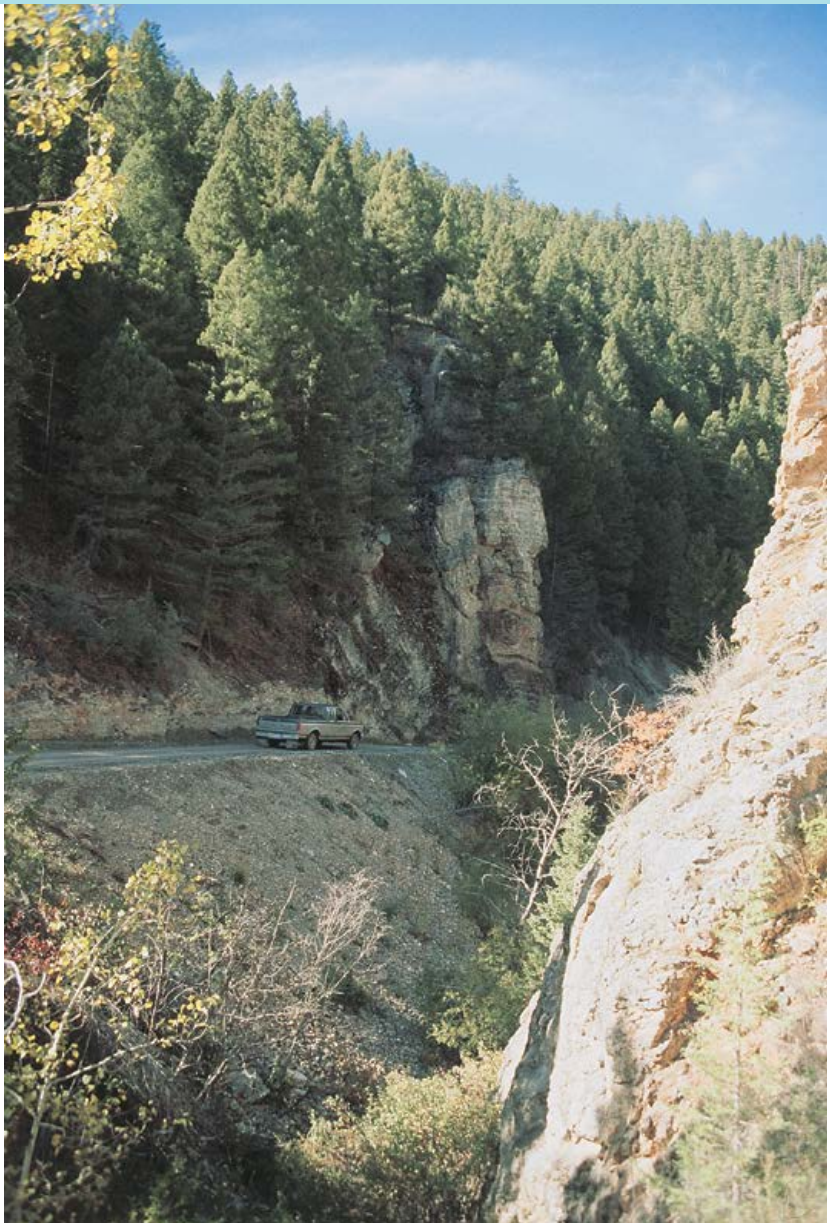
- any road construction where there is a risk of material entering a stream, lake or wetland
- road construction or reconstruction in any RMA
- conducting machine activity in Type F, SSBT or D streams, lakes or significant wetlands
- installing a stream crossing with a fill more than 15 feet deep
- placing logs or boulders in stream channels for stream enhancement

What do you need to know about stream crossings?

- They must be designed to handle 50-year peak flows.
- Crossing structures (e.g., culverts) must be passable by adult and juvenile fish for Type F and SSBT streams.
- Fish must be able to access side channels.
- The channel, any side channels and the floodplain must be protected.
- There are restrictions on the sizes of stream crossing fills.

• What is involved when locating a road near waters of the state?

- Minimize the total area disturbed by road fill.
- Minimize the excavation of stream-adjacent side slopes.
- Minimize the risk of materials entering water.
- Minimize disturbance to channels, lakes, wetlands and floodplains.
- Avoid locating roads in wetlands, RMAs or floodplains if alternatives exist.
- Minimize the number of stream crossings.



Avoid locating stream crossings in steep narrow canyons. If there is no alternative, a written plan must be submitted to ODF. Roads in these locations normally are not allowed unless there is no other way to manage the land.

Install drainage structures on flowing streams as soon as feasible.

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WHAT THIS MEANS:

Install structures quickly and keep equipment out of the stream, except the minimum necessary to build the road.

Basic stream culvert installation from start to finish.

Construction of culvert stream crossings has the greatest potential to cause immediate sediment pollution. Installing culverts is more than just placing a pipe in a stream. Complete the work promptly, at a time when the least damage will occur. A portable pump can be used to carry stream water around the construction site. The channel foundation and trench walls must be free of logs, stumps, limbs or rocks that could damage the pipe.

The culvert bed must conform with the natural streambed. The bed should be either rock-free soil or gravel. Bedding should provide even distribution of the load across the length of the pipe. All stream crossings on Type F or SSBT streams must be designed to provide fish passage. (See Page 131).

Secure each end of the culvert with backfill. Pour backfill material on top of the pipe. This allows finer soil particles to flow around and under the culvert sides. Larger particles roll to the outside. Fine soil particles, close to the culvert, compact more easily. Once the ends are secured by backfill, the center of the culvert is covered.

Tamping fill material throughout the entire backfill process is important. The base and sidewall material should be compacted first. This reduces any chance of water seepage into the fill.

Armor the culvert inlet and outlet. Rocks, logs or grass seeding can be used to protect these locations against erosion. Check the area upstream and downstream from the culvert. Clear the upstream area of woody debris that might plug the culvert.

The road approach to the new culvert is the next phase of construction. Be sure that the culvert fill above the top of the pipe is at least 18 to 24 inches, to protect the pipe from damage by traffic.

Layers of fill are pushed into place and carefully compacted to build up and maintain a consistent road grade. The crossing should be rocked to minimize the risk of sediment washing off the road and into the stream.

What are other best management practices for stream culvert installation?

- Install during low flows.
- Excavate the culvert bed as quickly as possible.
- Use a temporary dam, or pump stream water around installation, if the culvert bed is silt or clay material.
- Use clean gravel for the culvert bed when needed.
- Backfill around the culvert with native soil or gravel.
- Compact the backfill.
- Cover the fill with a gravel surface.
- Seed and mulch the area.

What are the different kinds of culverts, and how are they used?

Three styles of pipes, described below, are among the most common stream crossing culverts.

The style of pipe used is based on what will provide fish passage and handle peak flow.

1. Round Culverts

Round culverts are available in metal, plastic and concrete (metal and plastic are most common). They are used for small streams.

- Galvanized metal culverts, sometimes called CMPs (corrugated metal pipes), are most common.
- Plastic culverts, sometimes called CPPs (corrugated polyethylene pipes), are a popular alternative.

Round, galvanized corrugated metal pipe sunk into the streambed to allow for fish passage.

ADVANTAGES OF CMPS

- more crush-resistant
- fire-resistant
- more easily backfilled with a variety of backfill materials
- available in different lengths and shapes
- easily transported, one inside the other

DISADVANTAGES OF CMPS

- heavy, larger sizes require mechanical placement
- difficult to cut without cutting torch or power saw

ADVANTAGES OF CPPS

- light weight, easier to transport and install
- can be cut and joined with hand saw or chainsaw
- flexibility favors its use as downspouts (see photo at right)

DISADVANTAGES OF CPPS

- susceptible to melting in a forest fire
- prone to failure if not properly backfilled and compacted
- prone to puncture if coarse material is used for backfill

Arch culvert on a low clearance road, sunk into the streambed to allow for fish passage.

2. Arch (Squash) Culverts

- Arch culverts are used for stream crossings with low road clearance.
- Their larger bottom offers fish passage advantages.
- They require less road fill.
- They are more costly than round culverts.

3. Bottomless Arch Culverts

(Pictured On Page 131)

- They are the most expensive culvert installation.
- They require a concrete or rock foundation for support.
- They leave the stream bottom undisturbed.

The flexibility of a plastic pipe makes it a popular alternative to a metal culvert.

Minimize fill material by restricting the width and height of the fill to only that needed for safe vehicle use and provide adequate cover above culverts and other drainage structures

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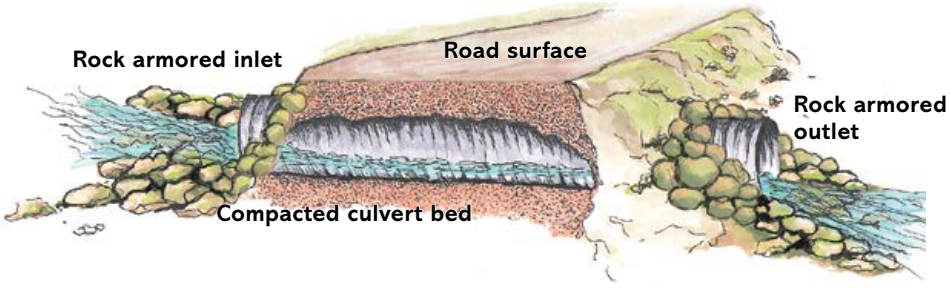
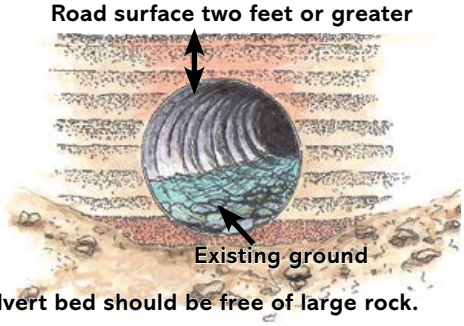
Stream culvert installation details

To provide for fish passage on Type F streams, one option is for culverts to be sunk into the streambed and embedded with streambed materials. This option is most appropriate for streams with up to an 8 percent gradient with deep valley fill. For streams with a gradient less than 2.5 percent, another option is a bare culvert placed at a zero grade (less than 0.5 percent) and sunk into the streambed a minimum of 6 inches.





Culvert bed should be free of large rock.

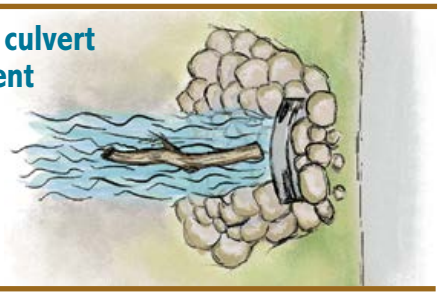
For an arch pipe, the culvert should be countersunk the greater of 20 percent or 18 inches. A round culvert should be countersunk the greater of 40 percent or 24 inches. This partial burial of the culvert into the streambed reduces water velocity in the culvert and allows gravel to deposit in the bottom. The effective width of the culvert should be equal to or exceed the width of the stream.

Tamp backfill material at regular intervals. Base and sidewall fill material should be compacted from finer soil particles. Fill height should extend at least 18 to 24 inches above the top of the culvert to protect the pipe from damage by traffic.

Incorrect culvert alignment

Incorrect alignment of culvert with stream results in accumulation of floating debris and eventual inlet plugging (overhead views).

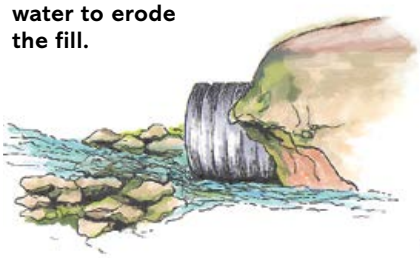
Correct culvert alignment

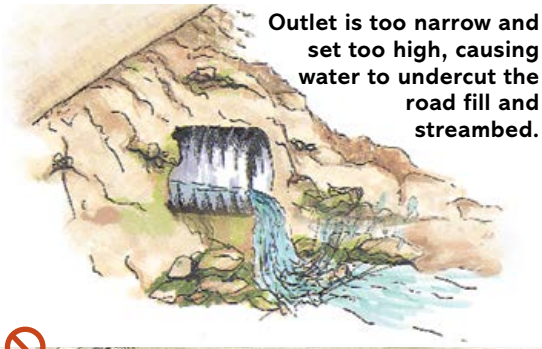


Common culvert installation problems

Culvert alignment is critical for proper culvert function. Culverts set at an angle to the channel can cause bank erosion. Skewed culverts can develop debris problems. Culvert alignment must fit the natural stream channel.

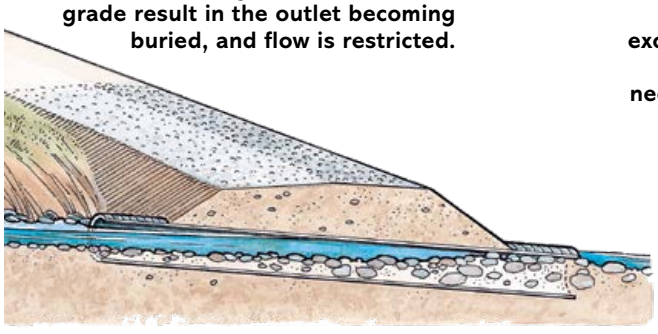
Inlet is too narrow, allowing water to erode the fill.



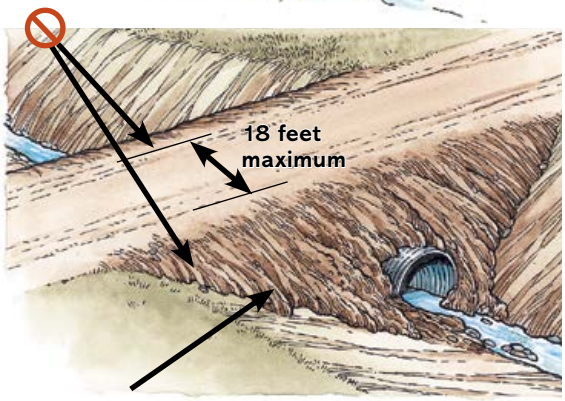


Outlet is too narrow and set too high, causing water to undercut the road fill and streambed.

Culverts installed at greater than stream grade result in the outlet becoming buried, and flow is restricted.



Never use a stream crossing to dispose of excess material. This road surface is wider than necessary and there's the risk of excess material entering the stream.



The slope of the fill slopes should be a maximum of 1½ :1. Soils unstable at such an angle (e.g., clays) should not be used.

How should you excavate side slopes near stream crossings?

Minimize excavation of side slopes near the channel.

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WHAT THIS MEANS:
(See illustration at right)

Use the minimum possible curve radius; about 50 feet for log trucks. This may make it difficult for any future lowboy traffic, which might require more gradual curves. Instead, plan that future logging equipment may have to drive to the site and not be delivered by lowboy.

What are the requirements for fills more than 15 feet deep?

Deep fills present risks if they fail and fill material is carried downstream. Written plans are required by ODF for fills more than 15 feet deep. The design of these fills must minimize surface erosion, embankment failure and downstream movement of fill material.

How do you prevent erosion of stream crossing fills?

Prevent erosion of the fill and channel.

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When stream crossing fills erode, it's likely the eroded material will enter the stream.

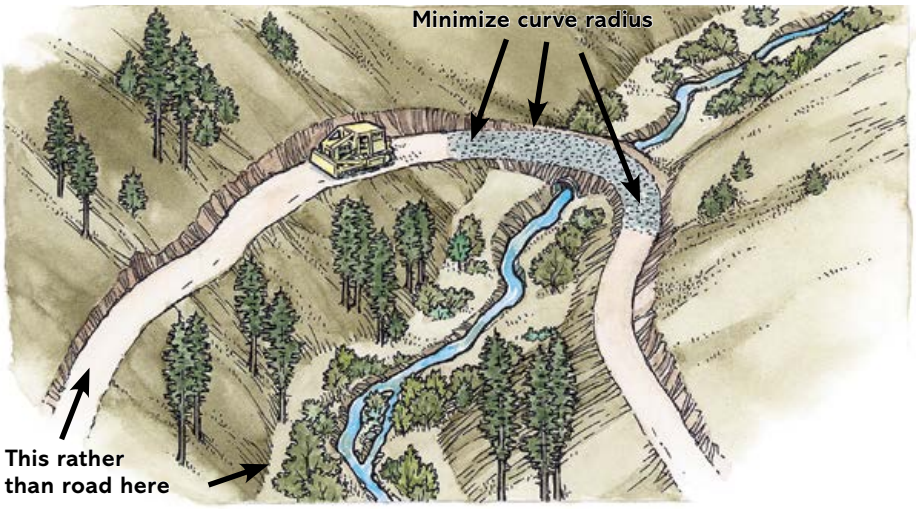
Seed and mulch fill slopes with appropriate species if germination will be successful prior to the wet season.

If not, use a non-erodible cover material such as clean gravel or riprap.

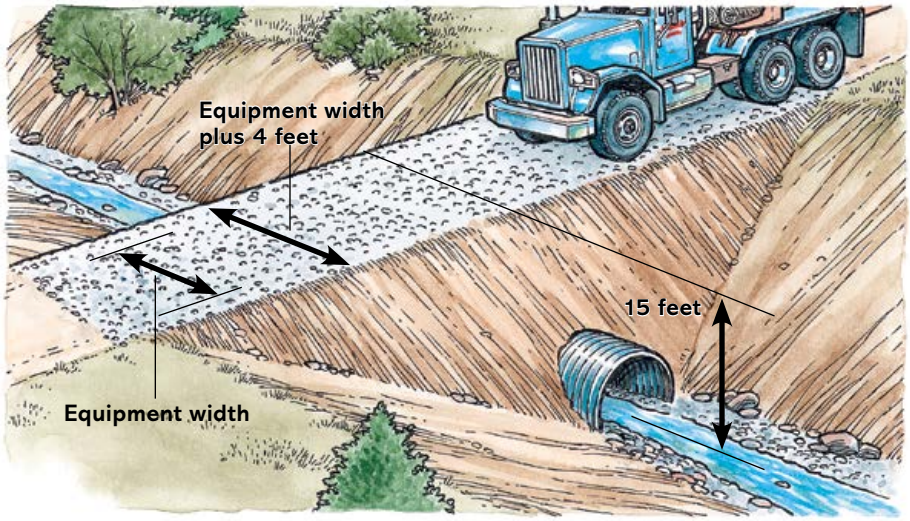
How do you avoid erosion of the stream channel below the culvert?

Install culverts that are equal to or greater than the width of the stream. This will prevent water from increasing in speed as it moves through the culvert and protect the channel below the culvert from erosion.

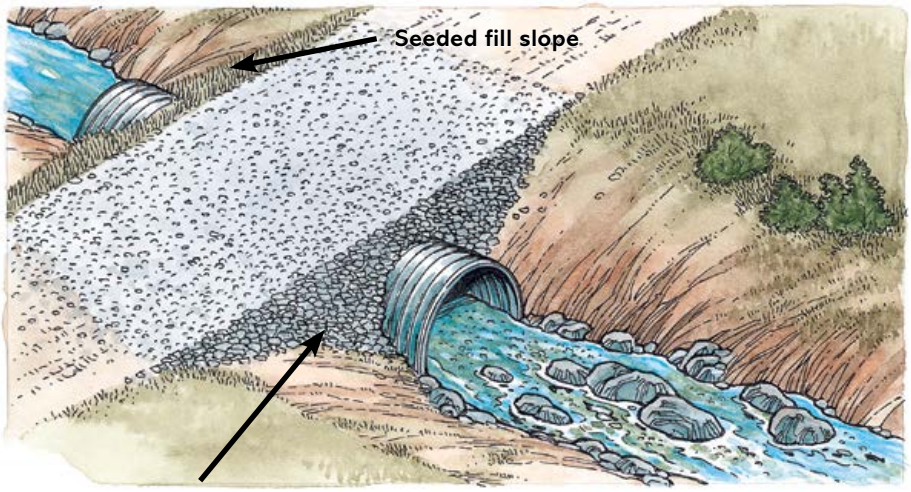
When crossing streams at right angles and where it is not necessary to place a curve in the road, the width of the fill at the top should not exceed 18 feet.



If possible, locate the road on side slopes of up to 50 percent rather than near the channel.



Where is fill depth measured? From the road running surface to the stream bottom at the downstream side.



Use gravel cover on fill slope if seeding may not be effective.

What about equipment restrictions?

Prior approval of ODF is required for machine activity in Type F, SSBT or D streams, lakes and significant wetlands.

Keep streambed machine activity to an absolute minimum.

Acceptable machine activity includes crossing the stream as necessary to construct the crossing. This activity is restricted to low flow levels.

Clear water and stable flows are indicators of low flow levels.

Do not divert water from channels except when necessary to construct stream crossings.

WHAT THIS MEANS:

Minimize stream channel disturbance and impact on aquatic life. However, sometimes it's helpful to temporarily divert stream water while constructing a stream crossing. Prior approval is needed.

What about flow requirements for stream crossings?

Stream crossings must handle heavy storm flows and also allow for fish passage. Design and construct culverts, bridges and fords to:

- pass a peak flow of at least a 50-year return interval; select a size adequate to preclude ponding of water higher than the top of the culvert
- allow migration for adult and juvenile fish upstream and downstream during conditions when fish movement in that stream normally occurs

WHAT THIS MEANS:

Design all stream crossing structures to pass the 50-year peak flow without washing out (see the Appendix, page 192).

Planning for a stream crossing must include flood calculations. When overlooked, the potential for water-quality damage is enormous. The costs of this plugged culvert road washout repair will far exceed the costs of a properly planned installation.

For Type F and SSBT streams, design all stream crossing structures to pass juvenile and adult fish upstream and downstream.

These requirements are for:

- all new road construction and reconstruction
- reconstruction of any partial or complete stream crossing washout
- replacement of any crossing structure

An exception to the 50-year peak flow requirement is allowed to reduce the height of fills where roads cross wide flood plains. The exception is allowed if all of these apply:

- The stream crossing includes a wide flood plain.
- The stream crossing structure matches the size of the active channel and is covered by the minimum fill necessary to protect the structure.
- Except for culvert cover, soil fill is not placed in the flood plain.
- The downstream edge of all fill is armored with rock of sufficient size and depth to protect the fill from eroding when a flood flow occurs.

WHAT THIS MEANS:

The intent is to reduce filling in channels and flood plains where there is a risk of major washouts.

Use this design when the flood plain at the crossing is many times the width of the active channel.

HERE'S AN EXAMPLE.

If a road is located in a wide flood plain, a very deep and wide fill may be needed for a new or replacement culvert that can handle a 50-year flow. To avoid the risks of such large fills, there is an option to use a smaller (or the existing) pipe with construction of

This vented ford is a cross between a ford and a culvert crossing. Water passes through the culvert during normal flows, but the structure can accommodate peak flows across a ford section during large storms.

an armored depression that can handle storm flows (see illustration below).

What about culverts and fish?

Fish move both upstream and downstream during different seasons to spawn, search for favorable water temperatures and find refuge or food during aquatic insect hatches. On Type F and SSBT streams, new stream crossings or any that are reconstructed or replaced must provide for upstream and downstream passage of both adult and juvenile fish.

If a culvert is used on a Type F or SSBT stream, you may be challenged to provide for adequate fish passage, especially upstream against fast-flowing waters. How the local stream features interact with pipe design, and placement must be carefully considered.

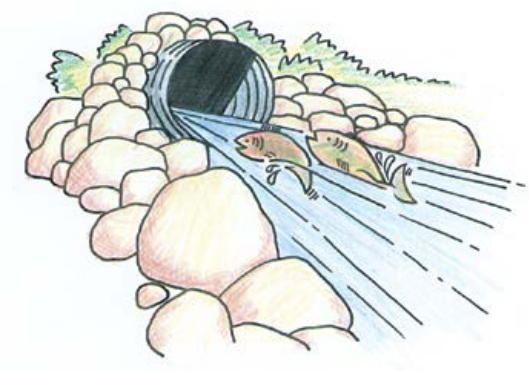
How can you make it easier for fish?

- Don't force fish to jump to enter a culvert.
- Keep culvert openings free of debris.
- Minimize culvert lengths.
- Locate culverts on a straight part of the stream.
- Set culverts below stream grade so streambed gravels can naturally accumulate in the culvert (note: A larger pipe size may be needed to accommodate a 50-year flow).

What's best for fish passage?

Each situation is unique but this is a general ranking of methods:

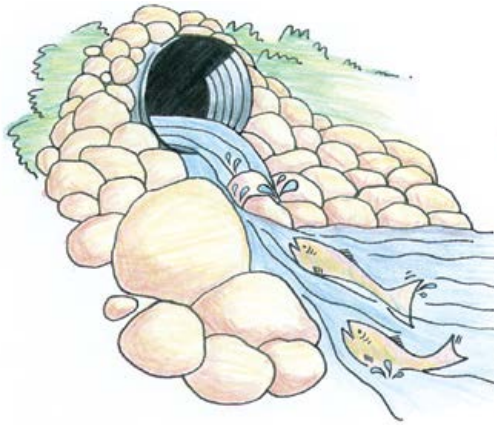
- re-route road (avoid/remove stream crossing)
- channel-spanning structure (long and short-span bridges; bottomless arches)
- fords (note: These are only suitable for low-traffic roads)
- streambed simulation (sunk and embedded culverts)
- bare culvert placed at a zero grade (culvert at <0.5 percent gradient and sunk for backwatering)
- hydraulic design (weir and baffle culvert designs)



Fish may not be able to swim fast enough to overcome culvert water velocity that develops in narrow culverts that are less than the width of the stream. Rule of thumb: water moving through a bare culvert that is turbulent (uneven water surface or whitewater) is probably a fish passage barrier.

Water may be too shallow for fish to swim. This can be a problem created by bare pipes. Shallow water leaves fish only partially submerged and unable to get maximum thrust from tail and body movements.

Ensure fish movement is not impeded.



There's no pool below the inlet for fish to rest in or jump from.

Hanging culverts can be too high to jump.

Bottomless arches leave the streambed intact, making it easier for fish to pass. Natural streambed roughness creates pockets of low water velocity where fish can move more easily. Footing should be secured to bedrock to prevent the structure from failing.

Install water crossing structures where needed to maintain the flow of water and passage of adult and juvenile fish between side channels or wetlands and the main channel.

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WHAT THIS MEANS:

All road projects involving construction or reconstruction work should address local needs for water flow and fish passage. Such projects include:

- minor road relocation
- replacement of stream crossing structures
- any road widening
- clearing of a road closed by trees growing on the surface
- opening of any old road

What about crossing structures on side channels?

Young fish find protection in wetlands and side channels during high flows. Culverts or bridges, added to old roads, can reconnect these fish habitats.

In some cases relocating the road can be a more effective way to reconnect these fish habitats (see illustration at right). This can reduce the number of stream crossings needed to maintain road access.

What about fords?

A ford is a stream crossing option for low-service-level roads that are private, gated and have infrequent use. Access control is important to avoid damage to the ford approaches when they are vulnerable to damage and erosion. Fords seldom have year-round access.

Unimproved fords, except those on solid rock, are generally inadequate for truck traffic. Traffic breaks down stream gravels and mud is brought into the channel from vehicle tires.

Requirements depend on how much use the ford receives.

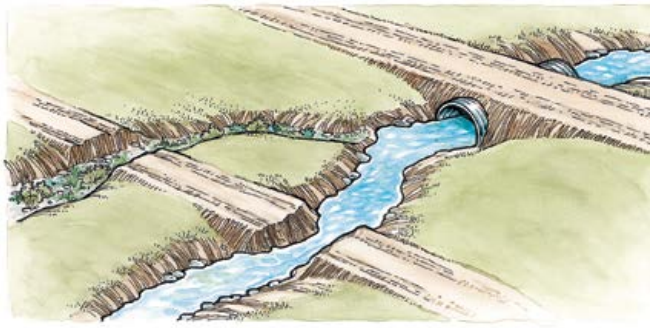
Where should a ford be located?

A bedrock stream bottom is ideal for a ford location. Otherwise, the bottom should be armored with suitable rock.

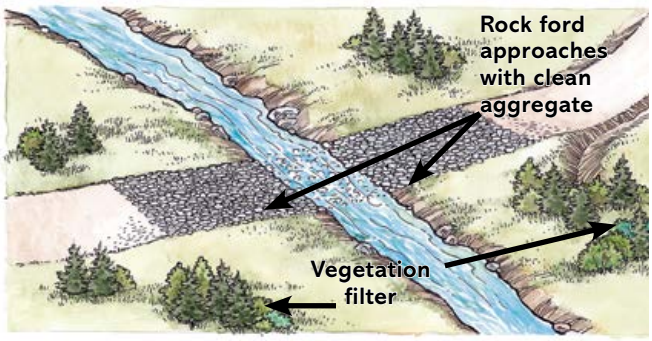
The size and shape of existing in-stream rock can guide the minimum size of armor rock required to resist downstream movement. It should be bigger than the common size in the stream bottom. Angular rock is preferred, because it resists movement by interlocking. Do not restrict fish passage.

Gently sloping, stable streambank approaches are preferred. Approaches should be rocked to minimize erosion when driving in and out of the ford. Where practical, approaches should be at right angles to the stream. Approaches should dip into and out of the stream, creating a concave shape that ensures the stream cannot be diverted out of its natural channel and down the road.

Early road construction techniques often filled side channels, contributing to the failure of main channel culverts during high water.



In this example, a minor relocation of the road prism resulted in only one culvert reinstalled for road access. This reduces maintenance and allows the side channel below the new crossing to be restored to a more natural condition.



Where there is light road use, fords with rocked approaches can be good alternatives to culverts. Well-designed and located fords can greatly reduce the amount of material at risk of erosion and delivery to streams during high flows.

What about bridges and bottomless arches?

These structures are the stream crossing of choice. They require carefully constructed abutments to avoid erosion and stream damage during high flows.

Avoid mid-span piers if possible. Not only are they costly, they often cause channel scour and are difficult to stabilize.

Use riprap to protect abutment fills from erosion.

Bridges are best for large streams and those plagued with floatable debris problems. Bridges and bottomless arch culverts have the least impact on fish when installed properly.

Keep road drainage under control. Even with grass cover, runoff and sediment have flowed around this abutment and drained directly into the stream.

Are there tips for new permanent bridges?

- Bridges should be sized to accommodate stream channel width and flood risk.
- Bridges and bridge approaches should be constructed to minimize soil or other material from reaching the stream.
- Whenever possible, existing vegetation and organic material should be retained around stream crossings to control erosion. Exposed soil should be covered with slash or other protective material.
- Abutments and wingwalls should prevent material from spilling into the stream.

Consider simple bridges for small Type F and SSBT streams. They can be similar or lower in cost compared to large, complex culvert installations.

What are the advantages of temporary portable bridges?

- handy for stream crossings on temporary low-standard roads
- useful when short-term access to forestland is cut off by a stream
- quick, economical and can be installed with minimal impact
- can be re-used in different locations as needed
- can restore crossings to their original condition

For other information sources, see the Appendix, pages 197-198.

A portable bridge provides access across streams less than 10 feet wide with minimal disturbance to streambanks or bed. Select locations with firm soil banks, level grade and minimal vegetation clearing.

Along with its portability, this bridge is strong enough for all harvesting activities.

This 20-foot portable bridge was hauled into place on a flatbed truck, and set into place in one day. The bridge cribbing is 10-foot timbers laid on the ground four feet from the bank.

A small tractor built the road approaches to the bridge. Over a three-week period, the bridge carried approximately 25 truckloads of logs.

When harvest was completed, the temporary bridge was removed.