

ROADS

Many of the rules listed are shortened for easier readability. There are exceptions: the “general definitions” are not shortened, and some WACs are shown in their entirety and labeled, “*This is the entire WAC*” under the WAC number.

For the reader’s convenience, all of the WAC chapters are hyperlinked so the rule can be seen in its entirety if desired.

The Board Manual parts are shown in their entirety.

Chapter 222-16 WAC, Definitions

WAC 222-16-010 General definitions.

“Fish passage barrier” means any artificial in-stream structure that impedes the free passage of fish.

“Forest practice” means any activity conducted on or directly pertaining to forest land and relating to growing, harvesting, or processing timber or forest biomass, including but not limited to:

- Road and trail construction;
- Harvesting, final and intermediate;
- Precommercial thinning;
- Reforestation;
- Fertilization;
- Prevention and suppression of diseases and insects;
- Salvage of trees; and
- Brush control.

“Forest practice” shall not include: Forest species seed orchard operations and intensive forest nursery operations; or preparatory work such as tree marking, surveying and road flagging; or removal or harvest of incidental vegetation from forest lands such as berries, ferns, greenery, mistletoe, herbs, mushrooms, and other products which cannot normally be expected to result in damage to forest soils, timber or public resources.

“Forest road” means ways, lanes, roads, or driveways on forest land used since 1974 for forest practices. “Forest road” does not include skid trails, highways, or local government roads except where the local governmental entity is a forest landowner. For road maintenance and abandonment planning purposes only, “forest road” does not include forest roads used exclusively for residential access located on a small forest landowner’s forest land.

“Full bench road” means a road constructed on a side hill without using any of the material removed from the hillside as a part of the road. This construction technique is usually used on steep or unstable slopes.

“Limits of construction” means the area occupied by the completed roadway or landing, including the cut bank, fill slope, and the area cleared for the purpose of constructing the roadway or landing.

"Load bearing portion" means that part of the road, landing, etc., which is supporting soil, earth, rock or other material directly below the working surface and only the associated earth structure necessary for support.

"Road construction" means either of the following:

- (a) Establishing any new forest road;
- (b) Road work located outside an existing forest road prism, except for road maintenance.

"Road maintenance" means either of the following:

- (a) All road work located within an existing forest road prism;
- (b) Road work located outside an existing forest road prism specifically related to maintaining water control, road safety, or visibility, such as:

Maintaining, replacing, and installing drainage structures;

Controlling road-side vegetation;

Abandoning forest roads according to the process outlined in WAC 222-24-052(3).

"Side casting" means the act of moving excavated material to the side and depositing such material within the limits of construction or dumping over the side and outside the limits of construction.

"Spoil" means excess material removed as overburden or generated during road or landing construction which is not used within limits of construction.

"Stream-adjacent parallel roads" means roads (including associated right-of-way clearing) in a riparian management zone on a property that have an alignment that is parallel to the general alignment of the stream, including roads used by others under easements or cooperative road agreements. Also included are stream crossings where the alignment of the road continues to parallel the stream for more than 250 feet on either side of the stream. Not included are federal, state, county or municipal roads that are not subject to forest practices rules, or roads of another adjacent landowner.

"Temporary road" means a forest road that is constructed and intended for use during the life of an approved forest practices application/notification. All temporary roads must be abandoned in accordance to WAC 222-24-052(3).

"Water bar" means a diversion ditch and/or hump in a trail or road for the purpose of carrying surface water runoff into the vegetation duff, ditch, or other dispersion area so that it does not gain the volume and velocity which causes soil movement and erosion.

Chapter 222-24 WAC, Road Construction and Maintenance

WAC 222-24-010 Policy.

- 1) A well designed, located, constructed, and maintained system of forest roads is essential to forest management and protection of the public resources...
- 2) To protect water quality and riparian habitat, roads must be constructed and maintained in a manner that will prevent potential or actual damage to public resources. This will be accomplished by constructing and maintaining roads so as not to result in the delivery of sediment and surface water to any typed water in amounts, at times or by means, that preclude achieving desired fish habitat and water quality ...
- 3) Extra protection is required during road construction and maintenance to protect public resources and timber growing potential ...

WAC 222-24-015 Construction in wetlands.

- 1) To assure no net loss of wetland function, all road and landing construction near or within wetlands must be conducted so that selection of choices are made in the following order with avoidance being the most preferred and replacement being the least preferred alternative:
 - Least environmentally damaging landing location, road location and road length. Minimize road length concurrently with the avoidance of wetlands; or
 - Minimize impacts by reducing the subgrade width, fill acreage and spoil areas; or
 - Restore affected areas by removing temporary fills or road sections upon the completion of the project; or
 - Reduce or eliminate impacts over time by preserving or maintaining areas; or
 - Replace affected areas by creating new wetlands or enhancing existing wetlands.
- 2) Accurate delineation of wetland boundary not required except where necessary to determine acreage of road or landing construction that fills or drains > one tenth acre of wetland. All such mapping must follow delineation and mapping standards outlined in the board manual, section 8.
- 3) Approximate determination of wetland boundaries, following the guidelines in the board manual, shall be required for the purpose of avoidance during design and construction of roads. Delineation, following the guidelines in the board manual is required to determine the length of road constructed within a wetland in order to determine acreage when replacement by substitution or enhancement of a wetland is required. The requirement for accurate delineation is limited to the area of the wetland proposed to be filled.
- 4) Filling or draining more than 0.5 acre of a wetland requires replacement by substitution or enhancement of the lost wetland functions. (See the board manual, section 9.) The objective of successful replacement by substitution of lost wetland area will be generally on a two-for-one basis and of the same type and in the same general location. The objective of enhancing wetlands function is to provide for an equivalent amount of function to replace that which is lost. See WAC [222-16-050](#) (1)(h).

WAC 222-24-020 Road location and design.

- 1) Fit to natural topography.
- 2) Parallel to streams: not located within natural drainage channels, channel migration zones, sensitive sites, equipment limitation zones, riparian management zones. New stream parallel roads require ID team review, federal services invited.
- 3) Not in bogs or fens.
- 4) Not in wetlands if there would be loss to wetland function.
- 5) Minimize number of stream crossings.
- 6) Crossings must be built to minimize alterations to natural features, sediment delivery, and at right angle to stream as much as practical
- 7) Avoid duplicative roads.
- 8) Use full bench construction techniques on side slopes >60 percent that have potential to deliver sediment to typed water or wetland.
- 9) Design standard must produce a road sufficient to carry the anticipated traffic load with reasonable safety.
- 10) Average subgrade width \leq 32 feet for two lane road, \leq 20 feet for one lane.
- 11) Balance excavation and embankments.

- 12) Cut and fill slopes assure stability.
- 13) Outslope and ditch on uphill side and provide appropriate surface drainage structures.
- 14) No discharge from drainage structures onto erodible soils or over fill slopes unless adequate outfall protection.
- 15) Relief culverts: \geq 18 inches western WA and \geq 15 inches.
- 16) Divert ditches from typed water or Type A or B wetland.
- 17) Outslope road surface where practical; where not practical, provide ditch with drainage structure.
- 18) Crown or slope the road to prevent accumulation of water on road surface.
- 19) Install rock armor headwall inlets where stream gradient above water crossing is >6 percent.
- 20) Install rock armored headwalls or ditchblocks for drainage structure culverts located on erodible soils or where road gradient is >6 percent.
- 21) Install drainage structures where there are seeps or springs.

WAC 222-24-026 Temporary roads.

- 1) Constructed to facilitate closure and abandonment.
- 2) Designed to provide same level of public resource protection as provided by rules.
- 3) Identified on FPA and abandonment date.

Board Manual Section 3, Forest Roads, Part 3. Road Location and Design

(Rules are in WAC 222-24-015, WAC 222-24-020, and WAC 222-24-026.)

The location of a road may have long-term effects on construction and maintenance costs, safety, and public resources. A well located, designed, and constructed road balances current and future needs with construction and maintenance costs. Base the final road location on field verified information, BMPs, and local knowledge.

3.1 Location BMPs

When necessary to cross water, find the optimal water crossings first. See 6.1 General Water Crossing BMPs. Then locate roads to:

- Utilize topographic features such as benches, ridges, and saddles.
- Use natural grade breaks to locate drainage structures. This prevents long continuous ditches.
- Avoid crossing or constructing roads adjacent to wetlands. When wetlands are present, refer to WAC 222-24-015(1) for an ordered list of choices for road location and construction. Recommendations on wetland restoration, enhancement or replacement are in Board Manual Section 9, Guidelines for Wetland Replacement by Substitution or Enhancement.
- Disconnect the road drainage from typed waters.

Reduce risks to public resources by minimizing the amount of roads in the following locations:

- On side slopes greater than 60%.
 - If you plan to construct roads in these areas, you may be required to use *full bench construction* techniques.
- On unstable slopes and landforms. For guidance, see Board Manual Section 16, Guidelines for Evaluating Potentially Unstable Slopes and Landforms.

- If you plan to construct roads in these areas, you may need to perform additional environmental review (see WAC 222-16-050, Class IV-special).
- In areas with a history of road failures or slides.
 - If you plan to construct roads in these areas, research the factors that contributed to the failures and plan to avoid past road location, construction and maintenance techniques. You may be required to perform additional environmental review (see Board Manual Section 16, Guidelines for Evaluating Potentially Unstable Slopes and Landforms and WAC 222-16-050, Class IV-special).
- Within 200 feet of typed waters.
 - Note: New stream adjacent parallel roads require an ID team.
- In or near seeps and springs.
 - If you plan to construct roads through seeps and springs, maintain the natural flow patterns around them. The flow pattern often has wetland indicator plants and soils.

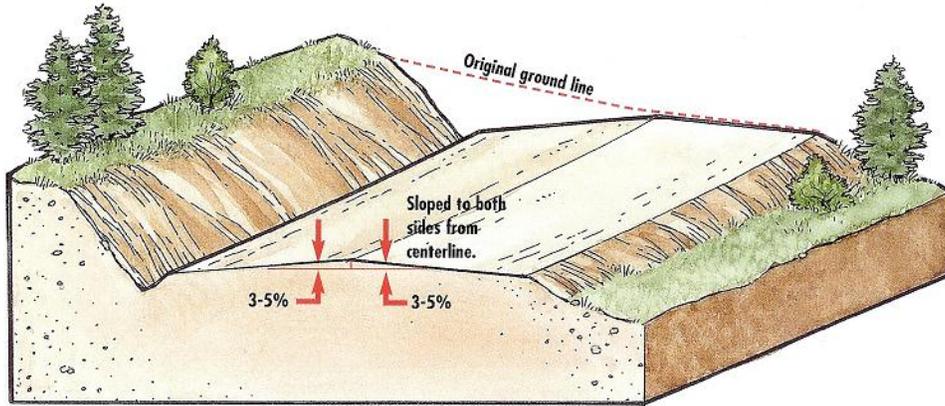
3.2 Design BMPs

Once you have selected a road location, design the road to minimize sediment delivery to typed waters by:

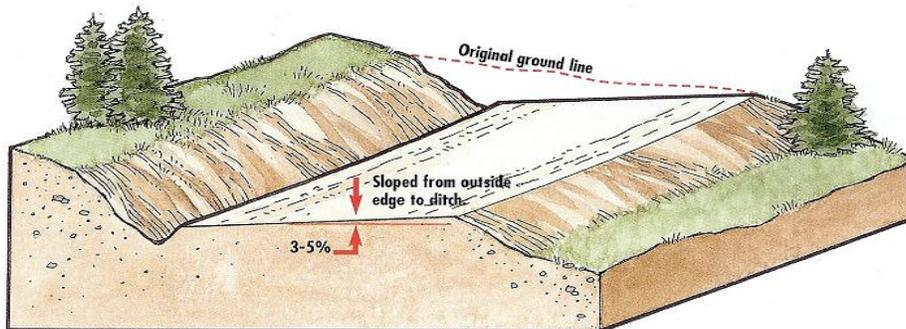
- Including adequate drainage structures for anticipated surface and intercepted sub-surface flow.
- Ensuring the sub-grade and surface can support log and rock haul during the planned season of road use.
- Not constructing sunken roads. These are roads lower than the surrounding ground level, and do not drain properly. Sunken roads occur on gently sloped land where cut and fill is unnecessary. In these locations, it may be necessary to build up the road surface so that water drains away from the road surface.
- Incorporating grade breaks to avoid long, continuous road grades.

Design the road shape (crowned, inslope, outslope) to support the anticipated haul of timber, rock, etc. Figure below shows cross section views of road sub-grades by type of road shape. The Table offers a comparison chart to help determine the best road design for your location.

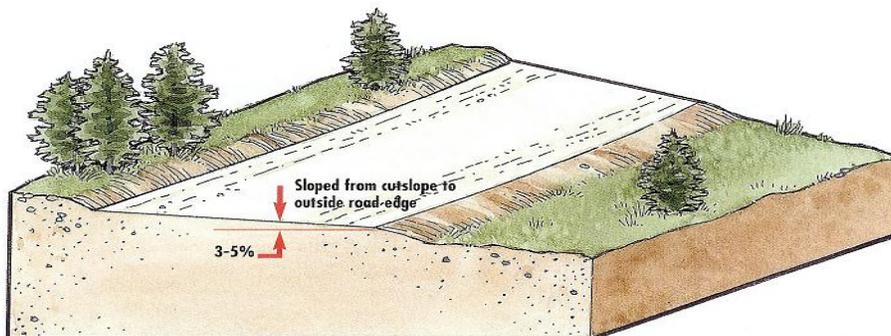
Crowned



Inslope



Outslope



Comparison Chart for Road Shape			
	Inslope	Outslope	Crown
Road surface shape	Drains towards the cut slope using the road or ditches.	Drains towards the fill slope using dips, not ditches.	Drains both directions with high point in center of road.
Construction requirements	Requires more excavation and clearing.	Requires less excavation and clearing.	Will require excavation and clearing quantities between inslope and outslope.
Maintenance requirements	Road surface Ditch and relief structures	Road surface Dips Fill slopes – vegetation or stabilization	Road surface Ditch and relief structures Fill slopes – vegetation or stabilization
Erosion concerns	Road surface Ditches At relief culverts and outlets	Road surface Fill slope Dips and dip outlets	Road surface Ditches At relief culverts and outlets Fill slopes
Where to use	When keeping runoff water in the ditch is critical to controlling sediment delivery. Unstable or erodible fill slopes Steep grades When hauling in ice or snow conditions	Rocky or well drained soils Where unable to maintain ditches Stable fill slopes On temporary or spur roads that are less than 8% grade.	Unstable or erodible fill slopes Steep grades When hauling in ice or snow conditions High traffic roads
Where not to use	Where ditches and relief culverts have high probability of clogging. Where ditches cannot be constructed.	Steep road grades High traffic roads Unstable fill slopes Where safety concerns exist, such as for use during ice or snow.	In areas, where outslowing the road is adequate. Temporary roads

WAC 222-24-030 Road construction.

- 1) R/W timber removed or decked where decks will not be covered by fill material.
- 2) No burying of stumps, logs, or chunks if >5 cu. ft. in load bearing portion of road, organic debris within 2 feet of load bearing portion of road, or debris or slash in any part of load-bearing portion of road.
- 3) Compact fills during road construction: fills or embankments built up by layering.
- 4) Erodible soils that could deliver sediment to streams must be seeded.
- 5) Stream channels must be cleared of debris and slash within 50 feet upstream from a culvert.
- 6) Install ditches and drainage structures concurrently with road construction. Outslope or install drainage structures when road uncompleted for extended periods.
- 7) Time construction when moisture not likely to result in excessive erosion or soil movement.
- 8) Endhaul or overhaul construction required where significant amounts of sidecast material would rest below the 100-year flood level of any typed water, within the boundary of a Type A or Type B Wetland or wetland management zones or where the department determines there is a potential for mass soil failure from overloading on unstable slopes or from erosion of side cast material causing damage to the public resources.
- 9) Waste disposal. When spoil, waste and/or other debris is generated during construction, this material shall be deposited or wasted in suitable areas or locations and be governed by the following:
 - a) Spoil or other debris shall be deposited above the 100-year flood level of any typed waters or in other suitable locations to prevent damage to public resources. The material shall be stabilized using the recommended schedule and procedures found in the board manual, section 3.
 - b) All spoils shall be located outside of Type A and Type B Wetlands and their wetland management zones. Spoils shall not be located within the boundaries of forested wetlands without written approval of the department and unless a less environmentally damaging location is unavailable. No spoil area greater than 0.5 acre in size shall be allowed within wetlands. (See WAC 222-24-015, Construction in wetlands.)
- 10) Disturbance avoidance for northern spotted owls ...
- 11) Disturbance avoidance for marbled murrelets ...

WAC 222-24-052, Road maintenance.

- 1) Road maintenance to prevent potential or actual damage to public resources:
 - a) Drainage structures kept functional
 - b) Ground water that has been captured by ditchline must be diverted to forest flow.
 - c) Road surface must be maintained as necessary to:
 - i) Minimize erosion of the surface and the subgrade
 - ii) Minimize surface water delivery to typed water
 - iii) Minimize sediment entry to typed water; and
 - iv) Direct ground water to stable portions of forest floor.

- d) During and on completion of the following operations, the road surface shall be crowned, outsloped, or water barred and berms removed from the outside edge except those intentionally constructed for protection of fills:
 - i) Log, pulp, chip, or specialized forest product haul;
 - ii) Rock haul; and
 - iii) Road building.
 - e) Before the first winter rainy season following termination of operations, drainage structures must be cleared and the road surface must be crowned, outsloped, water barred or otherwise left in a condition which prevents accelerated erosion, interruption of water movement within wetlands, mass wasting, or direct delivery of water or sediment to a typed water. (See the board manual section 3 for specific guidance.)
 - f) Thereafter, except as provided in (d) of this subsection, the landowner must clear or repair ditches or drainage structures that are known or should be known to be nonfunctional and causing or likely to cause material damage to a public resource.
 - g) The landowner will not be liable for penalties or monetary damages, under the act, for damage occurring from a condition brought about by public use, unless the landowner fails to make repairs as directed by a notice to comply.
 - h) During the regular course of road maintenance on stream-adjacent parallel roads, down wood that is blocking vehicle passage shall be placed on the side of the road closest to the adjacent water.
- 2) Additional drainage structure maintenance: where DNR determines the above maintenance has been or will be inadequate to protect public resources, DNR will require additional larger drainage structures or other improvements.
- 3) Abandoned roads.
- a) Roads are outsloped, water barred, or otherwise left in condition to control erosion and maintain water movement.
 - b) Ditches in condition to reduce erosion.
 - c) Roads blocked so four wheel highway vehicles cannot pass.
 - d) Water crossing structures and fills removed.
 - e) DNR determines if properly abandoned, notifies landowner.
- 4) Orphaned roads (roads not used for forest practices activities since 1974).
- a) Landowner inventory and risk assessment (public safety/resources) in RMAP.
- 5) Brush control. Done in accordance with WAC 222-38-020.
- 6) Road surface treatment.
- a) Apply oil only at >55 degrees F. and season when minimal chance of rain for 48 hrs.
 - b) Water prior to application for best penetration.
 - c) Construct temporary berm along road shoulder wherever needed to control runoff of applied chemical.
 - d) Extreme care – no excess chemicals – shut off flow at all bridges.
 - e) Dispose of rinse water fluids on road surface or a place safe from potential contamination of water when cleaning out chemical storage and equipment tanks.
 - f) Comply with WAC 222-38-020 when using dry chemicals.

Board Manual Section 3, Forest Roads, Part 4. Road Construction and Maintenance

4.1 General Construction BMPs

(Rules are in WAC 222-24-030)

- Provide road construction operators with well-marked road locations, readable road design information, and clear instructions.
- Supervise road construction operators to:
 - Ensure road width and cut depths match design specifications.
 - Respond to unanticipated circumstances.
- Construct roads when moisture and soil conditions are not likely to result in excessive erosion and/or soil movement.
- Minimize the area of soil disturbance during construction.
- Place all clearing debris and slash (such as tree limbs, stumps and brush) outside the road prism.
- For roads near typed water, place all clearing debris on the downhill side of the road at the toe of the road fill. This can trap sediment.
- New, non-compacted roads may need time to settle (several weeks or more) before rock or timber haul.
- Place a *geotextile fabric* over an inferior sub-grade before applying the surfacing material. This spreads vehicle load over the entire sub-grade and helps prevent the surfacing rock from sinking into the sub-grade soil.
- When crossing wetlands, follow the ordered list of choices for road location and construction in WAC 222-24-015(1). Recommendations on wetland restoration, enhancement or replacement are in Board Manual Section 9, Guidelines for Wetland Replacement by Substitution or Enhancement.

4.2 Compaction and Stabilization

(Rules are in WAC 222-24-030 and WAC 222-24-035.)

General Compaction BMPs

Compaction of the embankment, road sub-grade and landings ensures a solid earthen structure.

- Compacting the embankment reduces potential failure and surface erosion.
- Compacting the sub-grade extends the life of the running surface. It also reduces sediment runoff from the pumping of fine sediments upward into the road ballast and surfacing.
- Compacting the road surface and landings can shorten the settling time, extend rock surface life, and reduce sediment production during rainy weather.

For best compaction results:

- Place soil in 1 to 2 foot layers and run excavation equipment over the entire width of the lifts.
- Avoid incorporating organic material into any area to be compacted.

Compact during optimal soil moisture conditions. Determine this through observation and experience with different soil types. In soils with silt or clay, ideal soil moisture content is when you can squeeze the soil into a cohesive ball without having water form on the outside.

Special Case BMPs

In some instances, apply these additional techniques to enhance the sub-grade and road surface:

- On heavily used roads or where rock is expensive, use a roller to compact the sub-grade and surfacing. This extends the life of the road by:
 - Reducing the water intrusion.
 - Reducing the wear.
 - Improving the sub-grade's durability.
 - Maintaining the crown.
 - Enhancing the surfacing.

For this technique:

- Place surfacing in layers before compacting.
- Compact in several passes depending on the layer thickness. When there is no visible deformation of the surface, compaction is complete.
- If the sub-grade or surface rock is dry, spray on water or use a roller with a built in spray bar.
- If using a vibratory roller:
 - Place surfacing in 4 to 6 inch layers before compacting.
 - Compact until a sheen of water and fines rise to the surface.
- Use hard, angular rock that has a full range of fragments to tightly pack the road surfacing.

Stabilization BMPs

Stabilize all disturbed soils that have a potential to deliver sediment to typed waters. Stabilization methods include establishing vegetation and covering exposed soils with *bio-matting*, straw, tree boughs, or hydro mulching.

Waste soil (spoil) deposit areas should be located where material will not enter any typed waters if erosion or failure occurs. An area with stable, shallow slope topography is best suited for a spoil area. Compaction of spoil deposit areas reduces potential embankment failures, surface erosion, and helps fit material into waste areas. Apply the compaction techniques to spoil deposit areas:

- For best results, handle spoils when they are dry. Handling super-saturated material may require sediment controls (e. g., *silt fence*, berms, straw).
- Seed or plant disturbed soils with non-invasive plant species (native plants are preferred). Consider adding fertilizer and/or mulch if the site has poor nutrient quality and/or organic content.

4.3 Erosion Control

Erosion control measures are necessary if exposed soils can deliver sediment to typed waters. The key to controlling sediment is to control erosion. The best way to control erosion is to prevent it by:

- Covering all exposed soils with non-invasive plant species as soon as possible (native plants are preferred). Until the area can be vegetated, apply straw, logging slash or *fiber mats* to the exposed soil to prevent erosion from raindrop splash. This not only protects and holds soil particles from the erosive effects of rainfall; it also prevents the spread of noxious weeds.
- Scheduling construction during dry soil conditions.

4.4 Sediment Control

The goal of sediment control is to create a stable, dispersed, non-erosive drainage pattern. This minimizes potential or actual sediment delivery to typed waters. Where needed, sediment control BMPs include:

- Excavating *dead sumps* to intercept and settle sediment-laden water.
- Building *sediment traps* in ditch lines to create small sediment settling pools. Make *sediment traps* from rock, *straw wattles*, or sand filled bags. Orient the traps so they dip in the center and curve slightly. This keeps the flow centered in the ditch.
- Installing *slash filter windrows* to intercept sediment at the toe of fills over water crossings.
- Installing a secondary ditch or a raised berm over water crossings.
- Placing *straw wattles*, *silt fencing*, or *slash filter windrows* perpendicular to the hill slope to slow down and disperse water flow.

Use *sediment traps*, *silt fences* or *dead sumps* only as temporary or remedial measures because they require continuous maintenance. Install temporary *sediment traps* in any of the following situations:

- If erosion or sediment is likely to deliver to typed waters.
- If roads are built of erosive, native soils.
- If cut and fill slopes are difficult to vegetate.

BMPs for roads within 200 feet of typed water

Apply one or more of the following techniques on roads built of erosive native soils, or are likely to have ditch erosion, or have cut or fill slopes that are difficult to vegetate:

- Grass seeding.
- Armoring ditches.
- Constructing catch basins.
- Constructing temporary *sediment traps*.
- Rocking road surfaces near water crossings.

In situations where sediment control devices need to be used long-term consider surfacing that requires little to no maintenance such as chip sealing or paving portions of roads.

4.5 Vegetation BMPs

Consult with the Natural Resource Conservation Service, a county extension office or a State resource agency (DNR, Ecology, Agriculture) to determine the type of seeds and/or plants to use. Factors to consider are:

- Type of soils and soil conditions, including moisture content and degree of compaction.
- Available seed/plant sources (native plants are preferred).
- Costs and methods of seeding or planting.
- Avoiding invasive plant species.
- Matching the time of year the site is accessible with the appropriate planting of seed and/or plants.
- Topographic aspect, north or south facing slopes.

When applying grass seed to exposed soils:

- Consider using *straw blankets* or loose straw if soil moisture is low. Apply straw 3-6 inches thick.
- Seed during times of year that will allow germination without additional site visits to apply water.

4.6 Grading

To protect the sub-grade, grade a road before the surface reaches severe stages of pothole formation, wash boarding, or it begins to pool water. Grade only as needed to maintain the surface drainage and keep the sub-grade from becoming saturated.

Grading BMPs

- Determine the cause of potholes and wash boarding and fix the problem. The problem is usually standing water.
 - Cut out potholes and wash boarding. Pull road surfacing back onto running surface. This reduces water penetration and sub-grade saturation. Long-term solutions include restoring the road crown, adding rock, adding culverts, and ditching to reduce water in the road prism.
- Remove berms except those needed to carry water away from unstable slopes and/or typed waters.
- Compacting the graded surface with a roller will:
 - Seal the surface and retain fines.
 - Reduce potholes.
 - Reduce wash boarding.

Avoid the following practices:

- Unnecessary removal of all vegetation in functioning ditches.
- Undercutting the fill or cut slopes.
- Pushing sediment over steep slopes above typed waters.
- Burying vegetation, logging debris and slash into the road running surface or sub-grade. (Decomposition of this material will leave holes in the road surface. Traffic on this surface may cause sediment delivery to typed waters.)

4.7 Roadside Vegetation Maintenance

The purpose of roadside vegetation maintenance is to increase visibility, improve safety, control noxious weeds, and to keep roots from interfering with the roadbed and ditches. Methods include chemical application, hand brushing, and mechanical brushing.

Roadside chemical application BMPs

- Find and mark the location of all surface waters and wetland management zones immediately before applying roadside spray.
- Mix chemicals in upland areas away from all typed waters and Type A and B Wetlands.
- Prevent chemicals from entering any surface waters and Type A and B Wetlands and their buffers.
- Follow all label instructions.

- Know and follow regulations regarding chemical storage, handling, application, and disposal.
- Develop a contingency plan for spills, including clean-up procedures and proper notification. Keep this plan on site during operations.
- Apply chemicals during optimum weather conditions and optimum times for control of target vegetation. See Board Manual Section 12, Guidance for Application of Forest Chemicals.

Mechanical Brushing BMPs

- Remove brush to a width that allows proper maintenance functions such as grading, trimming shoulders, pulling ditches, and cleaning headwalls.
- Upon completion, remove all debris and/or slash generated during mechanical brushing that will interfere with proper function of ditches or culverts.

Board Manual Section 3, Forest Roads, Part 8. Road Abandonment

PART 8. ROAD ABANDONMENT

(Rules are in WAC 222-24-052(3).)

The goal of road abandonment is to re-establish the natural drainage and to leave the *road prism* in a condition that will not damage public resources or pose a risk to public safety. Abandoned roads do not require maintenance.

8.1 Prioritizing Roads for Abandonment

Consider abandonment of chronic problem roads that require frequent maintenance to protect public resources, such as:

- Stream adjacent parallel roads.
- Roads within a riparian management zone.
- Areas with uncontrollable erosion and/or sediment delivery to typed waters.
- Water crossing failures.
- Cut and fill slope failures.

8.2 Side Cast and Fill Removal BMPs

Remove side cast and fills if failures have the potential to damage a public resource or pose a risk to public safety. Areas to look for include:

- Cracks and slumps in the road surface or shoulder.
- On unstable slopes or landforms (see Board Manual Section 16, Guidelines for Evaluating Potentially Unstable Slopes and Landforms). The material should be end hauled to a stable location.
- Where the weight and volume of side cast material could cause a slide.

Removal methods:

- Place all excavated material against the cut slope or other stable location. Do not place in areas on the road surface that will allow water to pond.

- On steep slopes in high rainfall areas, do not place excavated material on the road surface. This material will become saturated and unstable.

8.3 Water Crossing Removal BMPs

Removing water crossing structures restores the natural drainage of streams. When removing water crossing structures:

- A completed FPA/N from DNR may be required. An HPA from WDFW may be required.
- Re-establish the natural streambed as close to the original location as possible and so it matches the up and downstream width and gradient characteristics.
- Place all excavated material in stable locations.
- Leave stream channels and side slopes at a stable angle.

8.4 Drainage BMPs

Install self-maintaining drainage structures that will not require future maintenance. Provide for drainage by:

- Removing relief culverts. Make sure side slopes are left at a stable angle.
- Removing berms or punching holes in them so they drain to a stable location.
- Ripping the road surface to promote re-vegetation.
- Installing non-drivable water bars:
 - To intercept the ditch. Make sure to key the water bar into the road cut-slope.
 - To direct outflow onto stable locations.
 - That are appropriately skewed:
 - For roads greater than 3% grade, skew at least 30 degrees from perpendicular to the centerline.
 - For roads less than 3% grade or at the bottom of a dip, install them perpendicular to the centerline.
 - At a spacing to disperse runoff and minimize erosion and sedimentation.
 - At natural drainage points.

WAC 222-24-035, Landing location and construction.

1) Landing location:

Locate landings to prevent potential or actual damage to public resources.

Avoid excessive excavation and filling.

Do not locate within natural drainage channels, channel migration zones, RMZ core and inner zones, Type Np RMZs, sensitive sites, equipment limitation zones, and Type A or B wetlands or their wetland management zones.

Minimize placement and size of landings within forested wetlands.

2) Landing construction.

a) Landings requiring sidecast or fill shall be no larger than reasonably necessary for safe operation of equipment.

b) Where the slopes exceed 60 percent, fill material must be free from loose stumps and excessive accumulations of slash and be mechanically compacted where necessary and practical in layers by tractor to prevent soil erosion and mass soil movement. Chemical compacting agents may be used in accordance with WAC 222-38-020.

c) Truck roads, skid trails, and fire trails shall be outsloped or cross drained uphill of landings and the water diverted onto the forest floor away from the toe of any landing fill.

- d) Sloped to minimize water accumulation.
- e) Excavation material shall not be sidecast where there is high potential for material to enter wetland management zones or within the bankfull width of any stream or the 100-year flood level of any typed water.
- f) All spoils must be outside of Type A and Type B Wetlands and their wetland management zones. Deposit no spoils within forested wetlands without DNR written approval and unless a less environmentally damaging location is unavailable. No spoil area greater than 0.5 acre allowed within wetlands. (See WAC 222-24-015, Construction in wetlands.)

3) Temporary landings.

- a) A temporary landing is intended for use during the life of an approved FPA/N.
- b) Must be constructed to facilitate abandonment when the intended use is complete or upon seasonal shutdown, whichever is sooner.
- c) Must be designed to provide the same level of protection for public resources as provided by the rules during the length of its intended use.
- d) Must be identified on the FPA/N, along with an abandonment date.
- e) Temporary landings must be abandoned to the specifications approved by DNR by the date specified on the approved FPA/N.

Board Manual Section 3, Forest Roads, Part 5. Landings

WAC 222-24-035(1) states, “Locate landings to prevent potential or actual damage to public resources. Avoid excessive excavation and filling. Landings shall not be located within natural drainage channels, channel migration zones, RMZ core and inner zones, Type Np RMZs, sensitive sites, equipment limitation zones, and Type A or B Wetlands or their wetland management zones.”

Landings can deliver sediment through runoff or mass failures (landslides). Reduce costs and risks to public resources by minimizing the number of landings on steep erosive slopes or large fills.

Utilize the road BMPs in Part 3 Road Location and Design and Part 4 Road Construction and Maintenance when locating, designing, and constructing landings.

General landing BMPs

- Use existing landings if properly located.
- Design landings to provide for drainage:
 - Slope landings 2-5%.
 - Install cross drains, ditch-outs, or other drainage structures to route runoff onto the forest floor away from typed waters.
 - Compact if appropriate.
- Construct when moisture and soil conditions are not likely to result in excessive erosion and/or soil movement.
- After completion of harvest:
 - Pull back fill material and woody debris on steep slopes that have the potential to damage a public resource. Place debris in a stable location.
 - Install self-maintaining drainage structures.

WAC 222-24-040 Water crossing structures.

(This is the entire WAC.)

(1) General provisions for all typed waters

In addition to the applicable general provisions below, installation, maintenance and removal of water crossing structures in or across the bankfull width of Type S or F Waters are subject to hydraulic code rules, chapter 220-110 WAC, and require hydraulic project approval (HPA) issued by the department of fish and wildlife. HPAs may be required on Type Ns and Np Waters.

(a) Bridges are required for new crossings and reconstructed crossings of any typed waters regularly used for recreational boating.

(b) Structures containing concrete must be sufficiently cured prior to contact with water.

(c) One end of each new or reconstructed permanent log or wood bridge shall be tied or firmly anchored if any of the bridge structure is within 10 vertical feet of the 100-year flood level.

(d) Alterations or disturbance of the stream bed, bank or bank vegetation must be limited to that necessary to construct the project. All disturbed areas must be stabilized and restored according to the recommended schedule and procedures found in section 3 of the board manual. This requirement may be modified or waived by the department, in consultation with the department of fish and wildlife, if precluded by engineering or safety factors.

(e) When earthen materials are used for bridge surfacing, only clean sorted gravel may be used, a geotextile lining must be installed and curbs of sufficient size shall be installed to a height above the surface material to prevent surface material from falling into the stream bed.

(f) Wood removed from the upstream end of culverts and bridges will be placed at the downstream end of such culverts and bridges in such a way as to minimize obstruction of fish passage and to the extent practical while avoiding significant disturbance of sediment, in connection with maintenance activities.

(2) Bridges over Type Np and Ns Waters. In addition to the applicable general provisions above, installation, maintenance, and removal of permanent bridges in or across Type Np and Ns Waters are subject to the following:

(a) Permanent bridges must not constrict clearly defined channels and must be designed and installed to pass the 100-year flood. The bridge and its associated embankments and fills must provide sufficient erosion protection to withstand a 100-year flood event.

(b) Excavation for and placement of the bridge foundation and superstructure must be located and conducted from outside the outer edge of the bankfull width. This requirement may be waived by the department, in consultation with the department of fish and wildlife, if it can be demonstrated that these activities may be conducted in such a manner to prevent damage to public resources.

(c) Earthen embankments constructed for use as bridge approaches must be provided with sufficient erosion protection to withstand a 100-year flood event.

(3) Culvert installation for Type Np and Ns Waters. In addition to applicable general provisions above, installation, maintenance and removal of permanent culverts in or across Type Np and Ns Waters are subject to the following provisions:

(a) All permanent culverts must be designed to pass the 100-year flood event with consideration for the passage of debris likely to be encountered.

(b) The culvert and its associated embankments and fills must have sufficient erosion protection to withstand the 100-year flood event. Erosion protection may include armored

overflows or the use of clean coarse fill material.

(c) If the department determines that because of unstable slopes the culvert size shown in the board manual, section 3, "Determining Culvert Size, Method A" would be inadequate to protect public resources, it may require a larger culvert designed using generally accepted engineering principles that meet the standards in (a) and (b) of this subsection.

(d) No permanent culverts shall be installed that are smaller than:

(i) 24 inches for Type Np Waters.

(ii) 18 inches for Type Ns Waters in western Washington.

(iii) 15 inches for Type Ns Waters in eastern Washington.

(e) The alignment and slope of the culvert shall parallel the natural flow of the stream whenever possible.

(f) Culverts must be designed and installed so they will not cause scouring of the stream bed and erosion of the banks in the vicinity of the project.

(g) When the department determines that installing a culvert in a flowing stream will result in excessive siltation and turbidity, and siltation and turbidity would be reduced if stream flow were diverted, the department shall require the stream flow be diverted using a bypass flume or culvert, or by pumping the stream flow around the work area. This may include culvert installations that are within 0.25 miles of a Type S or F Water or within two miles of a hatchery intake in consultation with the department of fish and wildlife.

(h) Fill associated with culvert installation must have sufficient erosion protection to withstand the 100-year flood.

(i) Stream beds shall be cleared for a distance of 50 feet upstream from the culvert inlet of such slash or debris that reasonably may be expected to plug the culvert.

(j) The entrance of all culverts shall have adequate catch basins and headwalls to minimize the possibility of erosion or fill failure.

(4) **Temporary water crossings in Type Np and Ns Waters.** In addition to the applicable general provisions above, installation, maintenance and removal of temporary bridges or other structures in or across Type Np and Ns Waters are subject to the following:

(a) A temporary water crossing is intended for use during the life of an approved application/notification.

(b) It must be constructed to facilitate abandonment when the intended use is complete or upon seasonal shutdown, whichever is sooner.

(c) Temporary water crossings must be identified on the forest practices application or notification, along with an abandonment date.

(d) Temporary water crossings may be used:

(i) In western Washington if installed after June 1 and removed by September 30 of the same year.

(ii) In eastern Washington if installed after the spring runoff and removed prior to October 15th.

(iii) At other times, when the department and applicant can agree to specific dates of installation and removal and the extended dates result in equivalent levels of resource protection.

(e) Temporary water crossings must be designed to pass the highest peak flow event expected to occur during the length of its intended use.

(f) When the department determines that installing a culvert in a flowing stream will result in excessive siltation and turbidity, and siltation and turbidity would be reduced if stream flow were diverted, the department shall require the stream flow be diverted using a bypass flume or

culvert, or by pumping the stream flow around the work area. This may include culvert installations that are within 0.25 miles of a Type S or F Water or within two miles of a hatchery intake, in consultation with the department of fish and wildlife.

(g) Temporary water crossings shall be promptly removed and abandoned to the specifications approved by the department upon completion of use or by the date specified in the approved forest practices application, whichever is earlier. Approaches to the crossing shall be water barred and stabilized at the time of the crossing removal. The department may waive removal of the water crossing if the applicant secures an amended forest practices application, and the structure and its approaches meet all of the requirements of a permanent water crossing structure.

(h) Temporary wetland crossings shall be abandoned and restored based on a written plan approved by the department prior to construction.

(i) Temporary water crossings must be designed to provide the same level of protection for public resources as provided by rules during the length of its use.

(5) Properly prepared and maintained fords may be used in Type Np and Ns Waters during periods of low water.

(a) Entry and exit points for each ford must be located as close to perpendicular along the stream as possible, but will not exceed 100 feet upstream or downstream of each other. Approaches to the ford will not run adjacent to the stream.

(b) Ford locations must be shown on the forest practices application.

(c) Best management practices for construction, maintenance and use will be utilized as appropriate or as required by conditions on the approved forest practices application.

Board Manual Section 3, Forest Roads, Parts 6 and 7. Water Crossings and Drainage Structures

PART 6. WATER CROSSINGS (Rules are in WAC 222-24-040.)

Water crossing structures are culverts, bridges, and fords. All of these structures can contribute sediment and negatively affect water quality and fish habitat. Installing or replacing water crossings usually requires a completed Forest Practices Application/ Notification (FPA/N) and may require a Hydraulic Project Approval (HPA) from Washington Department of Fish and Wildlife (WDFW).

6.1 General Water Crossing BMPs

Minimizing the number of water crossings in the following locations will reduce road costs and risks to water quality and other public resources:

- In areas requiring steep road approaches.
- Across braided stream channels.
- On flat stream gradients immediately downstream of steep stream gradients. (These areas are susceptible to high sediment deposition.)
- In areas requiring deep fills.
- Immediately downstream of unstable slopes or landforms (see Board Manual Section 16, Guidelines for Evaluating Potentially Unstable Slopes and Landforms).

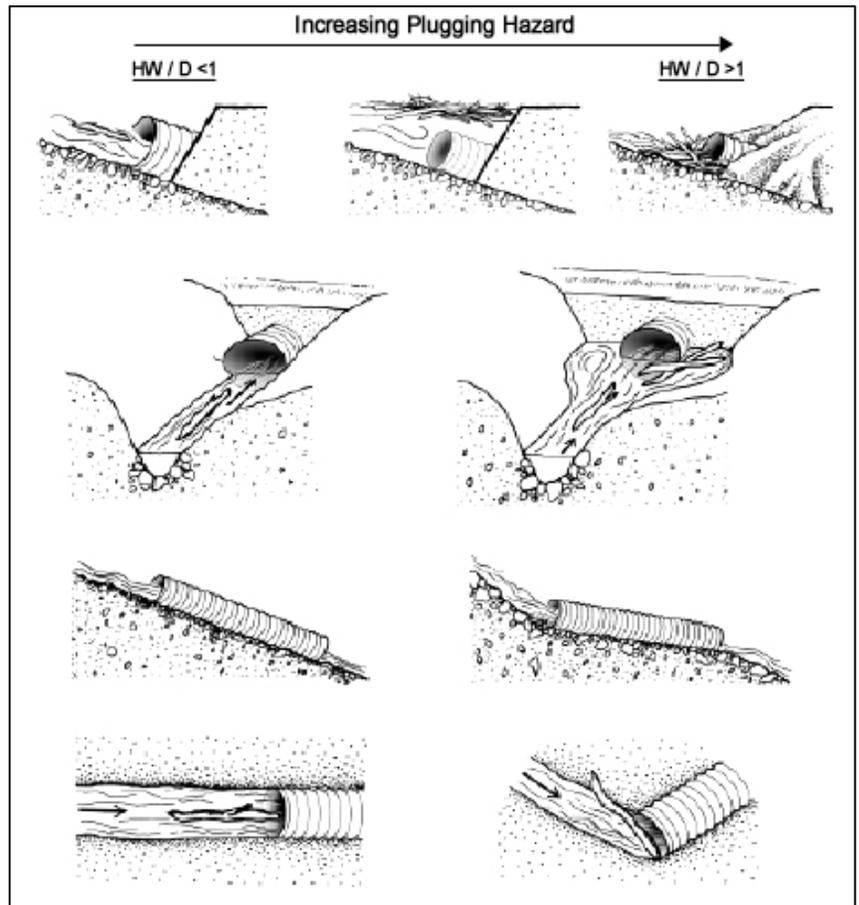
The Figure below provides guidance for culvert design and installation that will reduce potential catastrophic failures due to debris (wood and sediment) blockages.

Have a headwater depth to culvert diameter (HW/D) ratio of 0.9 or less when using native soils for the fill.

Match the culvert width to the natural channel to reduce ponding. Do not widen the channel at the inlet. This will help keep woody debris oriented to pass through culvert.

Match the culvert to the channel slope and elevation. This avoids pooling of the stream above the culvert.

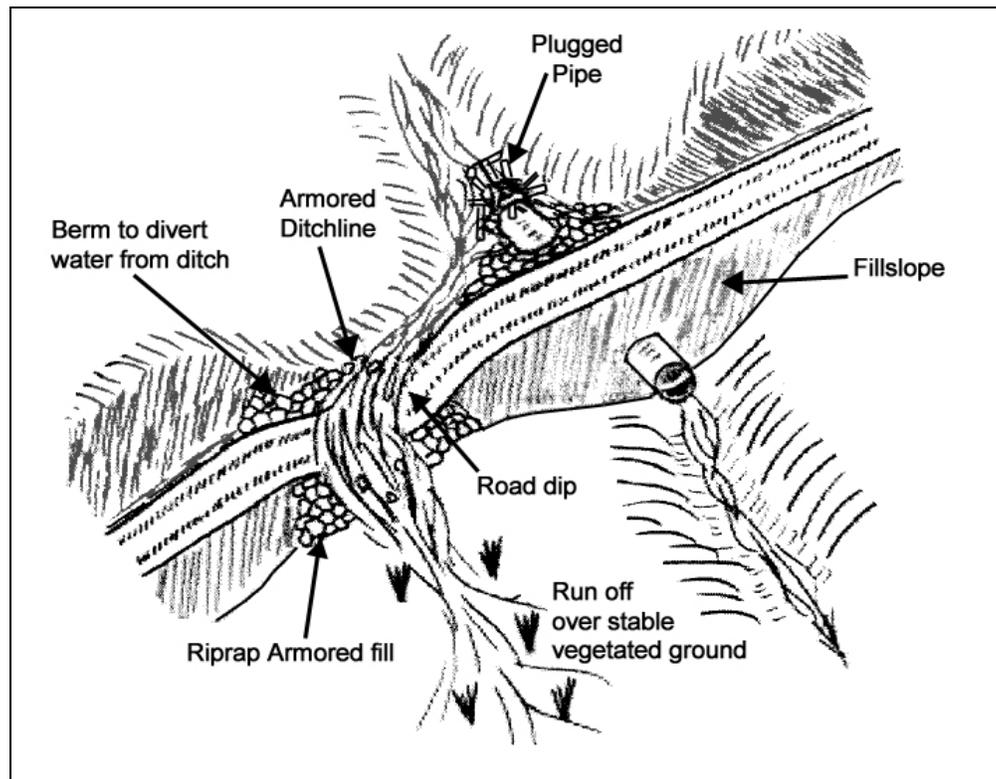
Align culvert with the stream channel.



Deeper fills and/or streams with greater debris transport potential BMPs

Steeper gradient streams often require deeper fills over the crossing structure and have increased amounts of woody debris. In areas where water can come over the road, select the BMPs or other measures from the following list that best fit the local conditions:

- Construct a dip on the fill over the stream crossing structure. This reduces fill erosion potential and improves resistance to road failures resulting from high water flows and debris. Use coarse material, compact the fill and armor with large rock.
- Dip the road grade and armor the fill to direct water onto stable, vegetated ground within the natural drainage, see Figure below.
- Outslope the road at the crossing.
- Construct an armored spillway at the intersection of the stream's gorge wall and the water-crossing fill.
- Place large riprap on the upstream facing fill and at the dip on the downstream facing fill.
- Install oversized inlets (bell-shaped inlet structures) or *miter* the culvert inlet to improve flow characteristics and to help orient debris.



Consider increasing the size of crossing structures when:

- The crossing is in the rain-on-snow zone.
- The stream contains large amounts of mobile debris (wood, gravel).
- The crossing is inaccessible during winter.
- The crossing requires deep fills.

- Crossing a flat, broad area with poorly defined channels.
- You are considering installing a new culvert with a diameter equal to or less than $\frac{3}{4}$ of the active channel width.

Water crossing construction BMPs

- Cover tops of culverts with at least 12 inches of fill, or to a depth of $\frac{1}{2}$ the culvert diameter, whichever is greater. This minimizes damage to culverts during road maintenance. It also distributes the weight of passing vehicles, preventing culverts from crushing.
- Prevent stream flow erosion by sizing culverts adequately. Placement of riprap around the inlet and/or outlet of a culvert may also prevent erosion.
- For natural surface roads, apply surface rock at culvert approaches.
- In areas where beavers are present, consult WDFW.
- Place slash and/or debris above the 100-year flood level outside of the riparian management zone or wetland management zone in a stable location.

Water crossing maintenance BMPs

Inspect all water crossing structures regularly and after storm events to ensure proper function. The following may indicate the need for maintenance or replacement:

- Stream flows regularly over the road.
- Stream flows diverted from the culvert inlet into the ditch. Look for severe erosion in the ditch located downhill from the crossing.
- Stream flows diverted from the culvert inlet into another stream channel (basin).
- Streambed material accumulations at the culvert inlet.
- Down-cut channel bottoms and eroded stream banks immediately downstream of the culvert (outlet scour/drop).
- Erosion of the fill located above the culvert inlet.
- Crushed or dented culvert inlets.

6.2 Water Crossing Structures in Type S and Type F Waters

The installation of water crossing structures in Type S and F Waters is regulated by DNR through the FPA/N and WDFW through the Hydraulic Project Approval (HPA). You can apply for both permits with the FPA/N. Water crossing structures in fish waters should allow for fish passage. Fish includes all life stages of resident and anadromous fish. Before designing water crossings, verify the water type with DNR. Information on crossing structures (Design of Road Culverts for Fish Passage) is located at <http://wdfw.wa.gov/hab/ahg>. Information on HPAs and design criteria is at <http://wdfw.wa.gov/hab/hpapage.htm>.

NOTE: Small forest landowners may be eligible for a state cost share program to help pay for fixing *fish passage barriers* through the Family Forest Fish Passage Program. Visit this website: www.dnr.wa.gov/sflo/ffpp or contact any DNR region office for more information.

6.3 Water Crossing Structures in Type N Waters

(Rules are in WAC 222-24-040.)

The first step in designing a Type N Water crossing structure is to verify the water type with the DNR. Then design your water crossing structure. Crossings need to be large enough to accommodate the 100-year flood with consideration for the passage of debris.

This section includes three methods to determine culvert sizing, any one of which can be used, see Table below.

Method A (Sizing Table Method) uses field-verified bankfull width and average bankfull depth and the Table to determine the diameter of the culvert. You may need additional size to accommodate debris if the culvert diameter size is less than $\frac{3}{4}$ the active channel width.

Method B (Bankfull Width Method) uses field-verified bankfull width at the stream crossing to determine the diameter of the culvert.

Method C (Hydraulic Design Method) is a hydraulic-based crossing design method that uses estimated stream flows. The size of the culvert is based on local 100-year flood flow calculations and the nomograph in Figure 3.4. Use local knowledge to predict additional culvert sizing to consider the passage of woody debris.

Three methods to size Type N Water culverts

	Method A Sizing Table	Method B Bankfull Width	Method C Hydraulic Design
Summary	Enter bankfull width and average bankfull depth into the culvert sizing table (Table 3.3).	Choose culvert diameter equal to or greater than bankfull width.	Calculate 100-year flow, determine culvert size using nomograph (Figure 3.4), and account for debris.
Complexity	Medium/Low	Low	High
Data Required	Measured bankfull width and average bankfull depth.	Measured bankfull width only.	100-yr flow (various methods and data requirements).
Analysis Required	Table 3.3	None	Peak flow calculation, use of nomograph (Figure 3.4).
Does Method provide for passage of debris?	Somewhat, except where culvert size is much smaller than bankfull width.	Yes	No– needs additional consideration.
Where to use	Where bankfull width and depth is easily determined. Where basin area and/or hydrology are uncertain.	When simplicity is required. Where bankfull width is clear, but depth uncertain. Where abundant	Where hydraulic expertise is available. Where site specific design and/or a non-round culvert are desired.

		mobile debris is present at the site.	Where bankfull width and depth is difficult to determine.
--	--	---------------------------------------	---

Method A, culvert sizing table for Type N Waters

Bankfull width (BFW) in Feet	Average Bankfull Depth in Inches											
	3	6	9	12	15	18	21	24	27	30	33	36
1	*15	*18	24	30	--	--	--	--	--	--	--	
2	24	30	30	36	42	42	48	48	--	--	--	B
3	30	36	42	48	48	48	54	54	54	60	60	60
4	30	42	48	54	54	54	60	60	66	66	72	72
5	36	48	54	54	60	60	66	66	72	72	78	78
6	36	48	54	60	66	66	72	72	78	78	84	84
7	42	54	60	66	72	72	78	78	84	84	90	90
8	42	60	66	72	78	78	84	84	84	90	90	90
9	48	60	66	78	78	84	84	90	90	90	96	96
10	54	66	72	78	84	84	90	90	96	96	96	--
11	60	66	72	84	84	90	90	96	96	--	--	--
12	66	72	78	84	90	90	96	96	--	--	--	--
13	66	78	78	90	90	96	--	--	--	--	--	--
14	72	78	84	90	96	96	--	--	--	--	--	--
15	78	84	90	96	96	--	--	--	--	--	--	--
16	78	84	90	96	--	--	--	--	--	--	--	--
17	84	90	96	--	--	--	--	--	--	--	--	--
18	84	90	96	--	--	--	--	--	--	--	--	--
19	90	96	--	--	--	--	--	--	--	--	--	--
20	96	96	--	--	--	--	--	--	--	--	--	--

* See WAC 222-24-040(3) for details relating to size restrictions when installing culverts.

Method A (Sizing Table Method)

Step 1: Verify the stream is Type N Water and then determine the bankfull width and average bankfull depth using methods shown in Board Manual Section 2, Standard Methods for Identifying Bankfull Channel Features and Channel Migration Zones.

Step 2: See the culvert sizing table (Table 3.3) to determine the diameter of the culvert. Consult with DNR for culvert diameters larger than 96 inches. For culvert sizes in the shaded areas of chart, it is recommended to use bridges, pipe arches, or open bottom culverts.

Method B (Bankfull Width Method)

Step 1: Verify the stream is a Type N Water. Measure the bankfull width in the field using the methods shown in Board Manual Section 2, Standard Methods for Identifying Bankfull Channel Features and Channel Migration Zones.

Step 2: Size the culvert diameter no smaller than bankfull width. *Note: This method may not be possible in areas that are difficult to accurately measure bankfull width.*

Method C (Hydraulic Design Method)

Method C is a hydraulic-based crossing design method that uses an estimate of stream flow for a 100-year flood to size culverts based on a nomograph. Figure 3.4 is a nomograph for calculating sizes for round corrugated metal culvert pipes on Type N Waters.

Limitations to the use of Method C:

- Hydraulic design method assumes there is culvert inlet control. This is a condition where the hydraulic capacity of the culvert is limited by the inlet configuration. This generally occurs in culverts steeper than 2% with unrestricted outflow.
- Flow measurements of past 100-year flood events may be unavailable.
- Estimated 100-year flow volumes may be hard to predict because of rain-on-snow events and inaccurate calculations of basin size.

Step 1: Verify the stream is Type N Water. Then determine the flow volume of the 100-year flood event (q value on the nomograph in the Figure below) by:

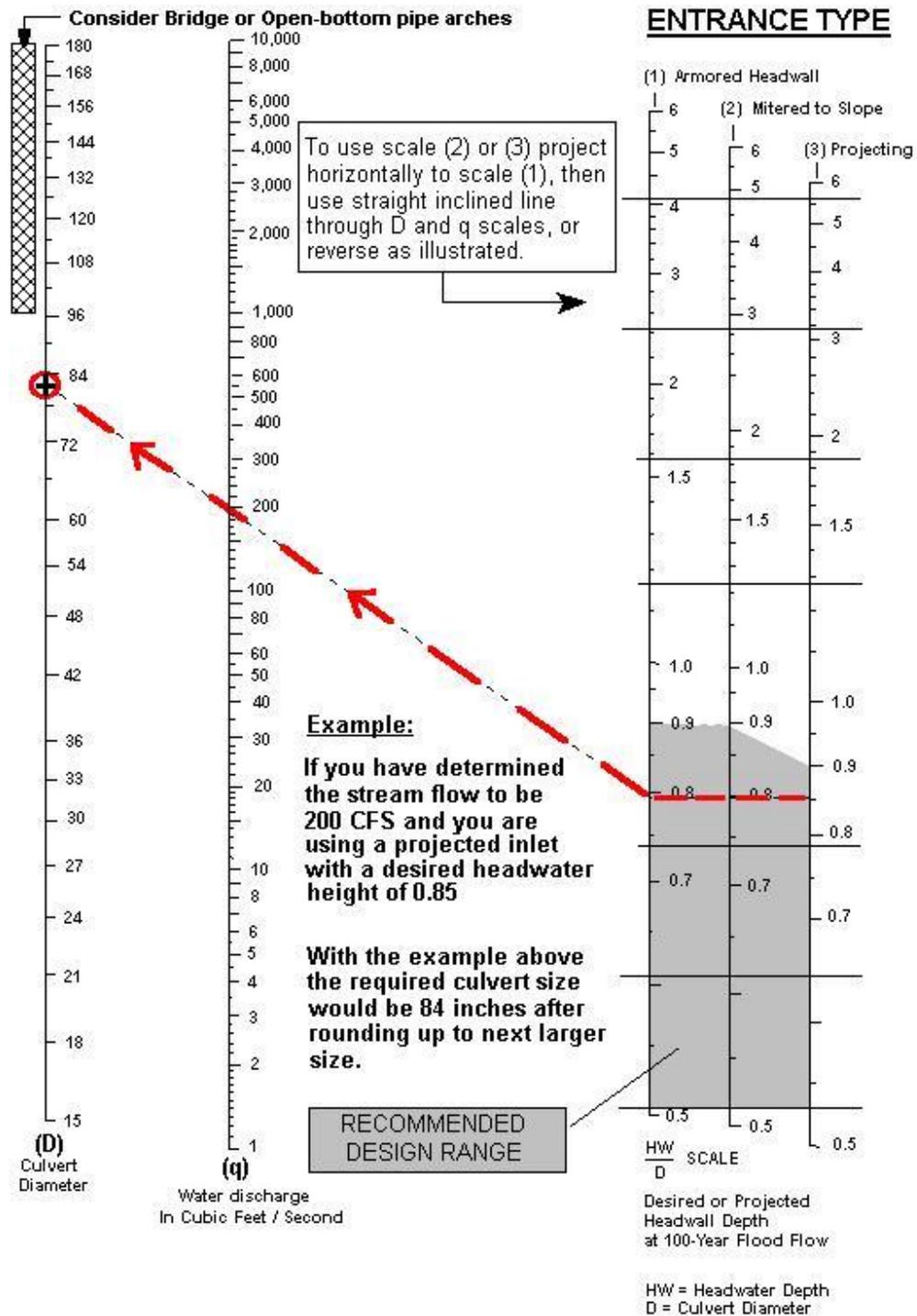
- Using stream flow records from gauged streams.
- Estimating the 100-year flood event. Table below lists three methods to estimate stream flows for 100-year flood events.

Step 2: Use the nomograph in the Figure below to determine the culvert diameter:

- Select culvert entrance type (armored headwall, mitered to slope, projecting).
- Select maximum headwater to culvert diameter ratio (HW/D). Do not exceed 0.9 when using native soils for the fill. This will ensure performance without reliance on hydraulic pressure to pass storm events.
- Project a line from the Entrance type bar through the Water Discharge bar (q) to arrive at a point on the Culvert Diameter bar (D).
- Round up to the nearest culvert diameter listed.
- Consider adding additional size to the culvert if debris is present in the stream.

Table, Three methods to estimate the 100-year flood event.

METHOD	COMMENTS
<p>Regression Equations Method</p> <p>Follow instructions at http://wa.water.usgs.gov/pubs/wrir/flood_freq/</p> <p>Further information may be found at http://water.usgs.gov/osw/streamstats</p>	<p>Easy to use web-based method.</p> <p>Uses a prediction equation with a standard error of 37% to 77%.</p> <p>Best used for basins greater than 50 acres.</p> <p>Developed using lower elevation stream flow gauge stations that measured larger basin areas typical in forest culvert design.</p>
<p>Flow Transference Method</p> <p>Follow instructions at http://wa.water.usgs.gov/pubs/wrir/flood_freq/</p>	<p>Useful method when water-crossing structure is in or near a gauged basin.</p> <p>Transfers in-stream gauge station information to an un-gauged drainage area.</p>
<p>Rational Method</p> <p>Follow instructions at http://www.wsdot.wa.gov/eesc/design/hydraulics/downloads.htm</p>	<p>Uses rainfall intensity maps or equations to calculate flow. (These maps may be difficult to obtain for forested basins.)</p> <p>Maps do not show flow from rain-on-snow events.</p> <p>Do not use on drainage basins larger than 200 acres.</p>

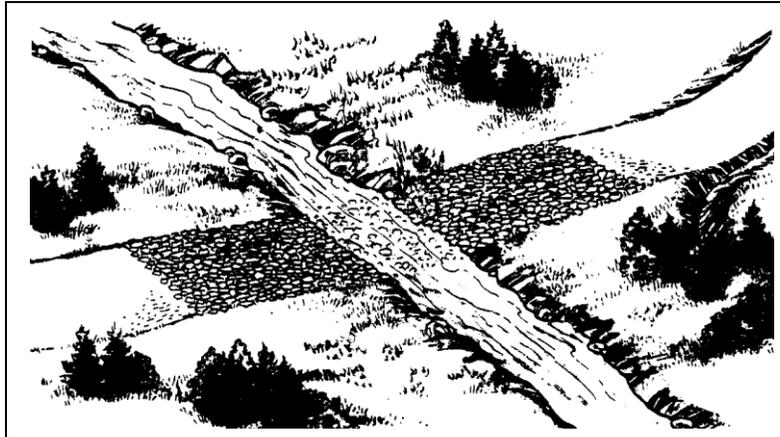


Figure, Nomograph for calculating sizes for round corrugated metal culvert pipe on *Type N Waters*.

6.4 Fords

You may use properly constructed and maintained fords in Type Np and Ns Waters. See WAC 222-24-040(5).

Fords are a type of water crossing where vehicles drive directly through streams, see Figure below. They have a high potential to generate and deliver sediment. Therefore, they are only appropriate to use during periods of no or low stream flow. If flow conditions change, a ford crossing may no longer be appropriate.



Fords may be suitable in the following circumstances:

- Minimal vehicle traffic.
- In sites where access limits regular maintenance.
- Variable stream widths exist from frequent landslides, debris flows, or ice flows originating upstream.
- When culverts or bridges are not an option because:
 - Crossing is too difficult to maintain.
 - High debris loading is present in stream channel.

Construction BMPs

- Fit the ford to the conditions on site (e.g., stream substrate and stream bank stability, stream width, depth and flow volume, lateral and vertical channel stability, flood frequency, debris loading).
- If streambed does not have a firm rock or gravel base, install stabilizing material. Use reinforced concrete planks, crushed rock, riprap or rubber mats.
- Make sure equipment is in good working condition and doesn't leak oil.
- Install ditch-outs or water bars on each side of the approaches to divert water away from the stream.
- Control erosion and sediment.
- Construct the ford so that you can maintain it.
- Construct temporary fords to facilitate abandonment and site rehabilitation.

Maintenance BMPs

Streambeds are part of a dynamic system where storm events frequently change the streambed and stream banks. Fords should not require maintenance after every such event. If frequent or extensive maintenance is required, re-evaluate the use of the ford.

Maintain fords to:

- Keep road approach ditch-outs and water bars functioning.
- Control stream bank erosion.
- Eliminate multiple approaches.

PART 7. DRAINAGE STRUCTURES

Landowners should take into account the need to reduce cumulative watershed effects from road sediment delivery to public resources. More intensive road work is needed in areas with closely spaced stream crossings and stream adjacent parallel roads. In these settings, not only are the potential impacts from road greater, but it may be difficult to find locations to direct sediment laden road run-off onto the forest floor. Where it is difficult to accomplish this there is greater value in applying BMPs that reduce sediment generation (e.g. improved surfacing) and ditch transport (e.g. silt traps). Drainage structures include relief culverts, dips, water bars, diversions, ditch-outs, and ditches. Drainage structures divert water and sediment from the road to the forest floor. They also disconnect road drainage from typed waters or Type A and B Wetlands. The frequency of drainage structures depends on several factors, such as:

- Road grade.
- Surface material.
- Elevation.
- Expected rainfall.
- Soil type.
- Road shape (inslope, outslope, crowned).
- Topographic opportunities for road drainage.
- Location of existing and/or planned drainage structures.
- Opportunity created by the road configuration.
- Local experience.

Install drainage structures in the following locations and order of priority:

1. As close to the stream as possible, to accomplish the following:
 - Limit the distance between the last drainage structure and water crossing structure.
 - Drain away from unstable hill slopes and/or erodible soils.
 - Allow outflow to disperse and filter sediment away from the stream.
2. In natural drainage areas of seeps and springs. If unable to install a drainage structure in the natural drainage area, divert and transport seep or spring water in a ditch for less than 100 feet to the nearest drainage structure.
3. To prevent diverting water from one basin to another.
4. At the low point on the road profile (including the sag point of vertical curves).

You may need to install additional drainage structures or improve road surface where:

- Ditch water delivers sediment to typed waters.
- The road is a stream adjacent parallel road.

- The density of stream crossings is high, resulting in most of the ditch length draining to streams.
- Ditch scour, road surface erosion, or outlet erosion is occurring from high ditch flow.
- Ditch flow exceeds the capacity of the culvert.

The Table below compares the construction costs, maintenance needs, and appropriate uses of relief culverts, dips, and water bars.

	Relief Culverts	Dips	Water bar
Construction costs	Highest	Medium	Lowest
Maintenance	<i>Medium</i> Needs frequent inspection and cleaning.	<i>Lowest</i> Needs occasional repair or reshaping.	<i>Highest</i> Needs frequent cleaning, reshaping and replacement.
When to use	On steep road grades. On high traffic roads. At the low point of the sag of vertical curves or dips.	On low traffic roads. On outsloped roads. To back up culverts. On dry sites and native surfaced roads.	On low traffic roads. On abandoned roads. To back up culverts. To winterize high traffic roads.
When not to use	On difficult to maintain roads. On seasonal roads. Below unstable or raveling cut slopes.	On steep grades (>12 %). On curves. On high traffic roads.	On high traffic roads.

7.1 Relief Culverts

Relief culverts divert road and ditch water onto the forest floor. Improper location of relief culverts may result in significant road-related resource damage. Overloading a site with drainage water can result in soil saturation and may cause overland flow, gully and slope instability.

Installation BMPs

- Where practical, place the culvert on the natural slope of the land with the low end of the culvert at least 2 inches lower than the upper end. When impractical, keep the culvert grade at least 2% higher than the ditch grade.
- Skew the culvert so it directs water 30 to 45 degrees from perpendicular to road centerline.
- No skew is necessary on roads less than 3% grade or at a low point on the road profile.
- Anchor the culvert by packing fill material around it.

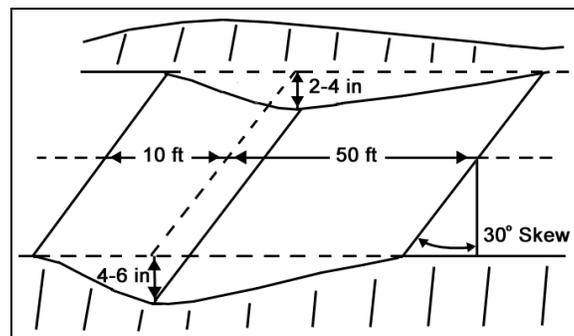
- Cover tops of culverts with 12 inches of fill or $\frac{1}{2}$ the culvert's diameter whichever is greater. (This minimizes damage from vehicles by preventing the culvert from crushing.)
- Install energy dissipaters such as flumes and down spouts on slopes greater than 60% or where the outfall drains onto fill or other erosive material.

Maintenance BMPs

- Inspect and clean culverts routinely and after storm events.
- Check need for additional cross drains for springs, seeps, low spots in ditch lines, and areas where ditch line erosion is occurring.
- Mark hidden relief culverts with posts so heavy equipment operators can see and protect them.
- Remove brush from around inlets and outlets to see problems and reduce the risk of blockage.

7.2 Dips

Dips are long, shallow road surface drainage structures that provide cross drainage on insloped road sections, see Figure.



Road grades from 12% to 15% are the upper limits for dips because:

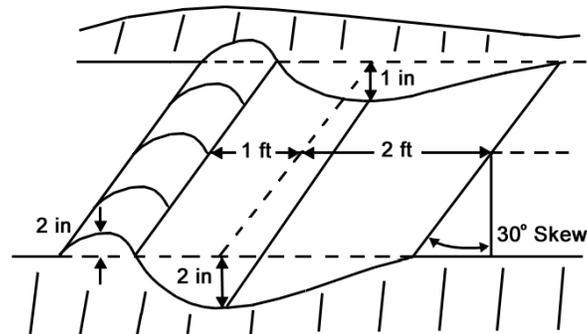
- If the dip becomes lower than the outfall it will not drain properly, impeding traffic and causing ruts and sedimentation.
- Truck frames can twist during passage over dips on steeper slopes.

Construct dips:

- To provide access for road maintenance and land management activities. When the dip is:
 - Short in length and traffic includes trucks with long frames, orient the dip perpendicular to the direction of traffic.
 - On steep road grades, skew the dip 30 degrees from perpendicular to provide drainage.
- With rock armoring on erosive native surface roads.
- With grass-seeded outflows when near typed waters.

7.3 Water Bars

Water bars divert surface water directly across the road and fill slopes to the forest floor, see Figure.



General water bar BMPs

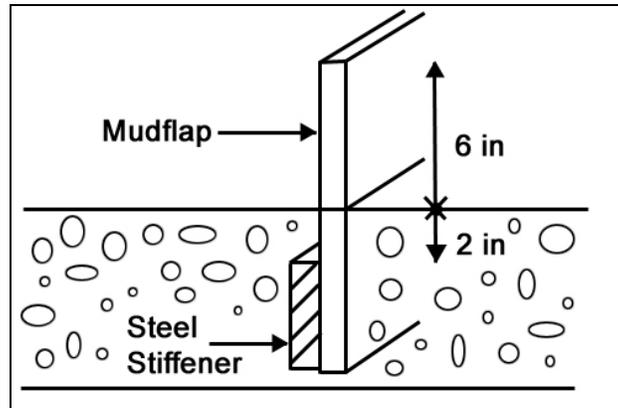
- Install water bars at a gradient steep enough to provide self-cleaning drainage with minimal maintenance:
 - For roads greater than 3% grade, skew at least 30 degrees from perpendicular to the centerline.
 - For roads less than 3% grade or at the bottom of a dip, install them perpendicular to the centerline.
- Locate outflows on stable areas.
- Construct water bars into the cut slope to block the ditch. These act as “safety valves” for failed relief culverts. They work best as temporary measures on low traffic roads with an inadequate number of relief culverts.
- Armor water bars at potential scour points (outflows, trench bottoms) with rock or other energy dissipaters.
- Construct temporary water bars for over-wintering by dumping piles of surfacing rock on the road. Later, grade them out for surfacing material.

7.4 Drainage Diversions

In rare circumstances (e.g., approaches to streams with wet weather haul), install diversion structures to drain the surface of the roadway, see Figure. These work best on low traffic roads and include:

- I-beams set in the road surface with edges on grade and at a 30 degree skew to the road centerline. The I-beam acts as a gutter to collect surface runoff and carry it away from the road surface.
- Rubber strips installed in the road surface at a 30 degree skew to the road centerline, see Figure. Mount the strips on buried wood or steel beams making sure that they stick above the road surface. Studies identified the following limitations to these surface water deflectors:
 - PVC belting tends not to rebound well under traffic and bends over parallel to the road grade. Rubber-laminated belting has less of this problem.
 - Road grading can rip these diversion structures out.

- Heavy winter hauling causes the top of some belting to fray and delaminate.
- On road grades less than 6%, potholes formed in the wheel ruts on the uphill side of the rubber strip.



7.5 Ditches

Ditches carry road runoff water to drainage structures.

Installation BMPs

- Typically, ditches should be at least one foot deeper than the road prism and have an approximate 2:1 slope on either side.
- If the ditch has the potential to drain a wetland, refer to WAC 222-24-015.

Maintenance BMPs

- Maintain ditch vegetation within 100 feet of water crossings. Vegetation filters sediment from ditch flow.
- Pull ditches only when necessary to maintain drainage. This helps maintain ditch function during a major storm event.
- Clean ditches of all debris generated during logging. Place this material on the downhill side of the road near the base of the fill.
- Do not undercut the road cut slope.
- Match equipment with the type of maintenance work required. Excessive excavation will create potential sediment delivery.
- Remove slides from the ditches and roadway.

7.6 Energy Dissipaters

The location and design of energy dissipaters is critical to prevent concentrated water runoff flows and gully formation on fill slopes or the forest floor. Install energy dissipaters on:

- Slopes greater than 60%.
- Erosive soils.
- Drainage structure outfalls.

Energy dissipaters include:

- Flumes or downspouts (half culverts staked into place).
- Large rock placed below outfall.
- Large woody material placed below outfall.