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Appendix R-1

Enhanced BMPs for New Roads		Rationale
1.	Where road grades slope toward stream crossings, driveable drain dips and/or ditch relief pipes will be located at the nearest practicable location to streams with an adequate filtration zone in order to minimize sediment delivery to streams. This will most often be where there is 25-75 feet of filtration below the drainage feature outfall and the stream and the drainage feature is 50-150 away from the stream along the road centerline. In addition to this drainage feature, a second drainage feature above crossings will be located within 400 feet of the first. If a drain dips cannot be constructed (e.g., due to road steepness), alternative methods will be employed to route road surface drainage into filtration zones (or sediment traps) to similarly minimize overall sediment delivery. Where soils at the outfall of drainage features would be subject to erosion, they will be armored with rock, slash, or other methods.	This NFHCP commitment is one of the most important for reducing sediment delivery to streams (See Technical Report #3). Idaho Forest Practices Act (FPA) Rule 040.02.e requires: "…plan drainage structures to achieve minimum direct discharge of sediment into streams." Montana Best Management Practice (BMP) III.C.6 requires: "Route road drainage through adequate filtration zones or other sediment-settling structures to ensure sediment doesn't reach surface water. Install road drainage features above stream crossings to route discharge into filtration zones before entering a stream." Washington FPA Rule 040.02.e requires: "Where roadside ditches slope towards a Type 1, 2, 3 Water…for more than 300 feet and otherwise would discharge into the stream…, divert the ditchwater onto the forest floor by relief culvert or other means at the first practical point." This NFHCP commitment adds specificity to the requirements in all three states. In Washington, it would enhance the protection by requiring this treatment on Type 4 and 5 waters as well as fish-bearing streams. Overall this commitment would greatly minimize sediment delivery to streams (See Technical Report #3).
2.	Road fills over stream crossings will be grass seeded and straw-mulched concurrent with construction. Other road cuts and fills on newly constructed roads will be seeded within one operating season. The tread on native-surface roads will also be grass seeded within one operating season unless the road will be used for hauling within two years of construction. Where needed to initiate grass growth, fertilizer may also be applied. At a minimum, fill slopes that are within 10 feet of streams will be straw-mulched.	All state regulations require that erosion control be undertaken on erodible fill slopes that could deliver sediment to streams and that this work should be done as soon as possible following construction. The NFHCP commitment would require Plum Creek to implement these measures on all fills within 10 feet of streams, regardless of erosivity, and that this work would be done concurrent with road construction. Research in the northern Rocky Mountains has found that this combination of practices can reduce fillslope erosion rates by over 80 percent (Burroughs and King 1989). This commitment was also extended to cutslopes and native-surface road treads as well, and the benefits anticipated should be similar to fills. Ten feet was selected as the primary contributing zone based on an empirical equation developed by Megahan and Ketcheson (1996) that predicts downslope travel distances below fillslopes.

Enhanced BMPs for New Roads		Rationale
3.	Slash Filter Windrows (or a suitable alternative) will be installed at the toe of all fillslopes within 50 feet of streams, and extended to encompass the closest drainage feature outlet (drive dip or culvert). Also, where operationally feasible, the slash filter windrow will be extended over the top of the culvert on the downstream side of the fill. If inadequate slash is available for construction of a windrow, other filtration means will be implemented to achieve the same, or greater, protection.	Research conducted in the northern Rockies has found that slash filter windrows can reduce fillslope erosion by 75-85% (Cook and King 1983). On slopes where filter windrows were applied, sediment travel distances below fills was less than 33 feet (Burroughs and King 1989). State regulations do not mandate the construction of filter windrows on new roads.
4.	Fills at culvert inlets (headwalls) on stream crossings (culverts ≥24 inches diameter) will be well armored with rock.	Streams have the potential to scour fillslopes at the inlets to culverts. Armoring fillslopes with rock is a tool for reducing this erosion that is not mandated at all times by state regulations.
5.	Stream crossing culvert installations in Idaho and Montana will be designed to accommodate at least the 50-year peak flood as determined by U.S. Geological Survey flood magnitude prediction procedures (as an alternative, the culvert size for a 50 year flood may be calculated by a Plum Creek hydrologist based on an analysis of channel dimensions). In Washington state, hydraulic regulations presently require sizing to accommodate at least the 100-year flood. The NFHCP will ensure that this is met as a minimum standard in Washington.	Sizing to accommodate the 50-year flood under the NFHCP would greatly exceed existing Best Management Practices in Montana, where 25-year sizing is presently the minimum standard. Based on local experience, sizing for the 50-year flood would mean that culverts would have dimensions approximating the natural channel. Sizing for more than the 50-year flood, while reducing the probability of culvert failure, would increase the environmental consequence of a failure since a larger fill would likely be necessary. Given these tradeoffs, and a permit period of 30-years, sizing for at least the 50-year flood should generally minimize impacts to covered species. In Washington, hydraulic permitting requires that culverts be sized to accommodate the 100-year flood. Under the NFHCP, culverts in Washington would still have to be sized to accommodate at least the 100-year flood.
6.	The road tread over stream crossings will be surfaced with rock on highly erosive soils. These are considered to be soils derived from deeply weathered granite and sedimentary rock, mica schist, and fine-textured lacustrine or glacial deposits. The minimum length to be rocked is 50 feet on either side of the crossing. Where road grades slope toward streams, rocking will extend to encompass the closest drainage feature above the crossing. Maps will be provided to foresters to aid in determining where these soils exist.	Surfacing road tread can reduce surface erosion by more than 75 percent (Swift 1984; Burroughs et al. 1985; Kochenderfer and Helvey 1987). This conservation measure is proposed on the most erosive soil types (Washington Forest Practices Board 1995). State regulations specify road surfacing as an optional management tool for controlling erosion.

Enhanced BMPs for New Roads		Rationale
7.	New roads that are proposed on sideslopes ≥70% will require a review for potentially unstable features. These include bedrock hollows, inner gorges, convergent headwalls and toes of deep-seated landslides (see Appendix R-8 for descriptions of these landforms). If potentially unstable features are identified where sideslopes exceed 70%, an attempt will be made to find a suitable alternative location. Where that is not feasible, a report will be prepared by a geotechnical specialist that evaluates risks of landslides on this segment of road and recommends ways to minimize risks.	The intent of this enhanced BMP is to provide more specificity in Idaho and Montana on how to treat potentially unstable areas. The Idaho FPA requires landowners to "Design embankments and waste so that excavated material may be disposed of on geologically stable sites." The Montana BMPs require that landowners "Locate roads on stable geology…avoid slumps and slide-prone areas…" This enhanced BMP will ensure that roads avoid these inherently sensitive areas or are designed in such a way that will protect the environment.
8.	Road cross-drainage will be provided as frequently as necessary to control road tread erosion. On active native-surfaced roads, road drainage features will be located such that road runoff distances generally do not exceed 300 feet (will not exceed 400 feet) along the road centerline. On highly erodible soil types, or on road grades steeper than 8%, this spacing will be reduced from the specifications listed above.	The Idaho FPA and Montana BMPs require that road surface drainage be adequate to control erosion. Research has found that sediment production is proportional to the product of road segment length times slope squared (Luce and Black 1999). Therefore, maintaining frequent drainage spacing is an effective strategy for reducing erosion. Cross drainage spacing guidelines are based on Packer (1967), Swift (1985), Haussman and Pruett (1973), and Rothwell (1978).
9.	Road clearing limits will be minimized where roads cross streams.	No specific state regulations or BMPs speak to this, but seems like a good management practice.
10.	Where seeps or springs are discovered during road construction, drainage features will be installed that pass accumulated surface water across the road prism and return it to the forest floor as close to the point of origin as reasonably practicable.	This BMP is presently being considered for incorporation in the WFPA, and no similar BMP exists in the IFPA or the MBMPs. At present, there is ongoing debate over the effects of roads on peak flows (Thomas and Megahan 1998). In conjunction with adding drainage around stream crossings and decreasing road drainage spacing, this BMP would seem to further minimize potential peak flow effects of roads.
11.	Roads located in Channel Migration Zones (CMZs) will be constructed with the minimum necessary fill depths, and include drainage features at all active channels.	This BMP will ensure that roads in CMZs do not restrict flood flows due to excessively high road fills.
12.	Stream crossing culvert installations must be designed to accommodate fish passage on fish-bearing streams (See Appendix R-6).	To maintain "connectivity," all new culvert installations must provide for fish passage on fish-bearing streams.

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Appendix R-2

Road Condition Inspections (RCI) Checklist

Road Condition Inspections that are performed after 1/1/99 to update the BMP status layer of the road database should adhere to the following described protocol. This is an update of the "BMP Status Verification Protocol" that was provided as instructions in a 4/15/97 memo from Bill Bennett and updated in a memo from Brian Sugden on 9/24/98.

Old RCIs are grandfathered. Information on road condition that was gathered according to the earlier instructions and entered in the BMP status layer is still valid. The newer protocol is revised slightly for the NFHCP, but is only intended to apply to the newer inspections. In this way we can improve our instructions from time to time as needed without having to go back and change everything that has already been inspected.

Roads will be inspected for their condition or BMP status in conjunction with routine forestry activities with additional inspections as needed to meet NFHCP targets. The condition of a road or road segment will be recorded with a colored highlighter pen according to the following classes and submitted to the Timber Operation Planning and Support group for an annual update as directed by John Woods.

- A field visit is required to verify a road or road segment as in compliance.
- The call that is made is only represented as the condition of the road or road segment on the day that it was field visited.
- Avoid micro-managing. Even though road segments technically go from a road junction or property line to another road junction or property line, make your call for a manageable road. For instance, if a ¾ mile long spur is clearly out of compliance, it makes no sense spend a lot of time to identify a 500-foot segment as in-compliance if the whole road will need to be upgraded. However, if it is clear that the road needs upgrading, a quick run down the road is in order to look for potential hot spots if there is a stream crossing.
- One of the four following calls must be made for every road where Plum Creek has sole or shared management responsibility. This includes:
  - Roads on Plum Creek land that are not public roads (i.e. County or State)
  - Access roads leading to Plum Creek where Plum Creek has rights and shares responsibility.

  It does not include private access roads where Plum Creek is given permission to use but no rights to maintain or upgrade.
- Pencil notes and annotations are welcome on maps submitted to TOPS.

The four status categories are:

- ❑ **In Compliance** (Green): Road segment has been field-inspected and has been determined to fully meet either Plum Creek's NFHCP enhanced BMPs for new roads or for old road upgrades.

- ❑ **Out of Compliance** (Orange): Road segment has been field-inspected and has been found to contain one or more locations that are not in compliance with enhanced BMP standards for new roads or old road upgrades, but are not serious enough to warrant a "hot spot" designation.

- ❑ **Hot Spot** (Pink): These segments have been field-inspected and are out of compliance and conditions are serious enough to warrant a this rating for priority treatment that will be accelerated from the normal old road upgrade target. Any of the following conditions warrant a Hot Spot designation.
  - ❑ Fish passage is blocked at a stream crossing
  - ❑ There is a washed-out culvert
  - ❑ There is directed sedimentation as evidenced by a 6-inch deep gully leading to stream
  - ❑ There is a perched fill that is unstable as evidenced by stress cracks in the road surface
  - ❑ There is a stream crossing culvert that is too short and leading to fillslope instability
  - ❑ Common sense dictates that the situation requires an accelerated or site specific action plan
  - ❑ Roads located where impacts cannot be remedied by standard upgrade of old roads

  → **Any road segment designated as a Hot Spot must be evaluated for accelerated action using the Hot Spot Planning form,** NFHCP Appendix R-4. All Hot Spots recorded on GIS must have a documentation of the problem and the action plan on file at the local forestry office. The Hot Spot Planning form is a tool for this documentation and action planning.

- ❑ **Not Verified** (Blue): Road segment has not yet been field-inspected.

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Appendix R-3

Enhanced BMPs for Road Upgrades		Rationale
1.	Where road grades slope toward stream crossings, driveable drain dips and/or ditch relief pipes will be located at the nearest practicable location to streams with an adequate filtration zone in order to minimize sediment delivery to streams. This will most often be where there is 25-75 feet of filtration below the drainage feature outfall and the stream, and the drainage feature is 50-150 away from the stream along the road centerline. In addition to this drainage feature, a second drainage feature above crossings will be located within 400 feet of the first. If a drain dips cannot be constructed (e.g., due to road steepness), alternative methods will be employed to route road surface drainage into filtration zones (or sediment traps) to similarly minimize overall sediment delivery. Where soils at the outfall of drainage features would be subject to erosion, they will be armored with rock, slash, or other methods.	This NFHCP commitment is one of the most important for reducing sediment delivery to streams (See Technical Report #3). Idaho Forest Practice Act (FPA) Rule 040.02.e requires: " . . . plan drainage structures to achieve minimum direct discharge of sediment into streams." Montana Best Management Practice (BMP) III.C.6 requires: "Route road drainage through adequate filtration zones or other sediment-settling structures to ensure sediment doesn't reach surface water. Install road drainage features above stream crossings to route discharge into filtration zones before entering a stream." Washington FPA Rule 040.02.e requires: "Where roadside ditches slope towards a Type 1, 2, 3 Water . . . for more than 300 feet and otherwise would discharge into the stream . . ., divert the ditchwater onto the forest floor by relief culvert or other means at the first practical point." This NFHCP commitment adds specificity to the requirements in all three states. In Washington, it would enhance the protection by requiring this treatment on Type 4 and 5 waters as well as fish-bearing streams. Overall this commitment would greatly minimize sediment delivery to streams (See Technical Report #3).
2.	Road cross-drainage will be provided as frequently as necessary to control road tread erosion. On active native-surfaced roads, road drainage features will be located such that road runoff distances generally do not exceed 300 feet (will not exceed 400 feet) along the road centerline. On highly erodible soil types, or on road grades steeper than 8%, this spacing will be reduced from the specifications listed above.	The Idaho FPA and Montana BMPs require that road surface drainage is adequate to control erosion. Research has found that sediment production is proportional to the product of road segment length times slope squared (Luce and Black 1999). Therefore, reducing drainage spacing can reduce sediment production. This enhanced BMP clarifies existing regulation by specifying maximum drainage feature spacing. Cross drainage spacing guidelines are based on Packer (1967), Swift (1985), Haussman and Pruett (1973), and Rothwell (1978).

Enhanced BMPs for Road Upgrades		Rationale
3.	Where existing stream crossing culverts have fulfilled their design life (or been washed out) in Montana or Idaho, replacements will be designed to carry the 50-year peak flood as determined by U.S. Geological Survey flood magnitude prediction procedures (as an alternative, the culvert size for a 50-year flood may be calculated by a Plum Creek hydrologist based on an analysis of channel dimensions) In Washington, stream crossing culvert replacements will be sized to accommodate at least the 100-year flood, per existing hydraulic regulations.	Sizing to accommodate the 50-year flood under the NFHCP would greatly exceed existing Best Management Practices in Montana, where 25-year sizing is presently the minimum standard. Based on local experience, sizing for the 50-year flood would mean that culverts would have dimensions approximating the natural channel. Sizing for more than the 50-year flood, while reducing the probability of culvert failure, would increase the environmental consequence of a failure since a larger fill would likely be necessary. Given these tradeoffs, and a Permit period of 30 years, sizing for at least the 50-year flood should generally minimize impacts to Permit species. In Washington, hydraulic permitting requires that culverts be sized to accommodate the 100-year flood. Under the NFHCP, culverts in Washington would still have to be sized to accommodate at least the 100-year flood.
4.	On stream-adjacent/parallel roads, when the outfall of drainage features (existing or added) are too close to streams for effective forest-floor sediment filtration (based on field observations), supple-mental sediment filtration will be provided (e.g., slash filter windrows, straw-bales, silt fences, etc.) or road drainage feature frequency increased, so that sediment delivery is minimized. If this cannot be effectively done, the road segment will be re-classified as a Hot Spot and treated under NFHCP Commitment R6.	Idaho FPA Rule 040.02.e requires: "…plan drainage structures to achieve minimum direct discharge of sediment into streams." Montana BMP III.C.6 requires: "Route road drainage through adequate filtration zones or other sediment-settling structures to ensure sediment doesn't reach surface water. Install road drainage features above stream crossings to route discharge into filtration zones before entering a stream." Washington FPA Rule 040.02.e requires: "Where roadside ditches slope towards a Type 1, 2, 3 Water…for more than 300 feet and otherwise would discharge into the stream…, divert the ditchwater onto the forest floor by relief culvert or other means at the first practical point." This NFHCP commitment adds specificity to the requirements in all three states.
5.	For stream-adjacent/parallel roads or where there is a high density of stream crossings, simple/ inexpensive re-location will be utilized in addition to (or in lieu of) road drainage improvements where possible. When inexpensive re-location is not possible and drainage improvements will not greatly reduce sedimentation impacts, the road segment will be re-categorized as a Hot Spot and treated under NFHCP Commitment R6.	This BMP is relatively self-explanatory. To the greatest extent possible, we will try to control the impacts from roads adjacent to streams by managing road drainage and/or simple road relocation. If this is not possible, an Hot Spot designation will be given that will allow us to weigh the cost of fixing the problem versus the environmental benefit.
6.	Where upgrading or road use exposes bare mineral soil, disturbed areas will be grass seeded during appropriate soil moisture conditions before the end of the current operating season.	Research in the northern Rocky Mountains has found that the presence of vegetative cover can greatly reduce erosion rates (Burroughs and King 1989).

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Appendix R-4

Hot Spot Action Planning Form

Forester: _____

Inspection Date: _____

Location of Hot Spot: S/T/R, Where on road?	Description of Hot Spot

Consult prioritization worksheet (Appendix R-5). Priority: _____

Implementation target date: _____

Description of action:

Note: If the cost of repair exceeds the benefits of having the road, road abandonment should be considered.

File with Hot Spot Action Planning

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Appendix R-5

Hot Spot Prioritization

Evaluation of Overall Benefit of Hot Spot Treatment:

Utility:

- Number of native fish species benefited:_____
- Number of listed species benefited: _____
- Imminent threat posed by Hot Spot? _____
- Length of stream benefited by treatment:_____
- Magnitude of benefit in watershed/stream condition by fixing the Hot Spot (H, M, L):_____
- The amount of habitat benefited by correction (e.g., a few meters of stream benefited versus six miles of stream) (H, M, L):_____
- Amount of overlap with other goals (e.g., TMDLs, wildlife, etc.) (H, M, L):____

Using your judgment, assign an overall utility score on scale of zero-to-ten (0-10) based on factors above (note: when needed, Plum Creek science staff could assist in evaluating project benefits). Score = _____

Probability of Success:

Based on your best judgment, rank the probability of success on a scale of zero-to-ten (0-10). Where necessary consult Plum Creek science staff. Score = _____

Multiply the Utility score and the Probability of Success score to obtain the overall benefit score: Overall Benefit Score = _____x_____=_____

Once you have the score, assign an Overall Benefit based on the following: Minor (0-33), Moderate (33-66), Significant (66-100).
Overall Benefit (Significant, Moderate, Low) = _____

Evaluation of Hot Spot Treatment Cost:

Estimated Hot Spot Treatment Cost = $_____
Low (cost <$10,000), Moderate (cost $10,000-$20,000), High (cost >$20,000).
Cost Category = _____

Overall Priority (Based on Matrix Below): _____

	Cost of a Given Hot Spot Treatment		
Benefit of Hot Spot Treatment	**Low Cost**	**Moderate Cost**	**High Cost**
Significant Benefit	PC Priority 1	PC Priority 2	Priority Cost-Share
Moderate Benefit	PC Priority 2	PC Priority 3	Cost-Share*
Minor Benefit	PC Priority 3	PC Priority 4*	Cost-Share*

* Further investigation of these projects required to fully evaluate benefits and identify cost-share partners before implementation is considered to be warranted.

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Appendix R-6

Fish Passage Insert of NFHCP Implementation Manual

This key serves as a tool for Plum Creek foresters in determining whether a particular stream crossing should be considered as a fish passage barrier. Following the key will result in one of three outcomes:

1. Does not pass: The culvert is a fish passage barrier and should be treated as a hot spot.

2. Passes: The culvert may be considered to be allowing for fish passage.

3. Go to measurements: The conclusion is more difficult to determine without a more detailed look. The forester must take measurements according to the measurements page and send to a Plum Creek fish biologist for final determination.

1a Natural slope of stream above and below culvert remains < or = to 25%. (Go to 2)
1b Natural slope of stream above and below culvert remains > 25%. (Stream is not fish-bearing, fish passage not required)

2a Slope of culvert matches upstream and downstream slope of streambed. (Go to 5)
2b Slope of culvert is different than upstream and downstream slope of streambed. (Go to 3)

3a The culvert is perched above the water level on the downstream side. (Go to 4)
3b The culvert is not perched and the bottom of the pipe is at or below water level on the downstream side. (Go to 5)

4a The bottom of the culvert is within 6 inches of water level. (Go to 5)
4b The bottom of the culvert is >6 and <18 inches from the water level. (Go to measurements)
4c The bottom of the culvert is >18 inches from the water level. (Does Not Pass)

5a An adequate pool is available at the downstream end of the culvert to provide a resting area for fish. (Go to 6) [Adequate pool: unobstructed, depth > or = outfall height and length > than or = to two times outfall height]
5b No adequate pool available, stream is characterized by rough water. (i.e. riffles, white water, drop off) (Does not Pass)

6a The minimum thalweg depth of the water in the culvert is four inches. (Go to 7)
6b The minimum thalweg depth of the water in the culvert is less than four inches. (Go to measurements)

7a The culvert is less than 90 feet in length. (Go to 8)
7b The culvert is greater than 90 feet in length. (Go to measurements)

8a The culverts interior is corrugated. (Go to 9)
8b The culverts interior is smooth. (Go to measurements)

9a Water velocity through the culvert is equivalent to average velocity above and below the culvert. The velocity does not exceed four feet/sec. (Culvert passes)
9b Water velocity though the culvert is very swift. The water velocity exceeds four feet/sec. (Does not pass)

Culvert Measurements

Crossing #_____ (Sec. Twn. Rng. Unique)

Slope of Pipe (%)_____ **OR** Rise_____ / Run_____

Stream Gradient (%)_____ Deposition in inlet Yes / No

Length of culvert_____(ft.)

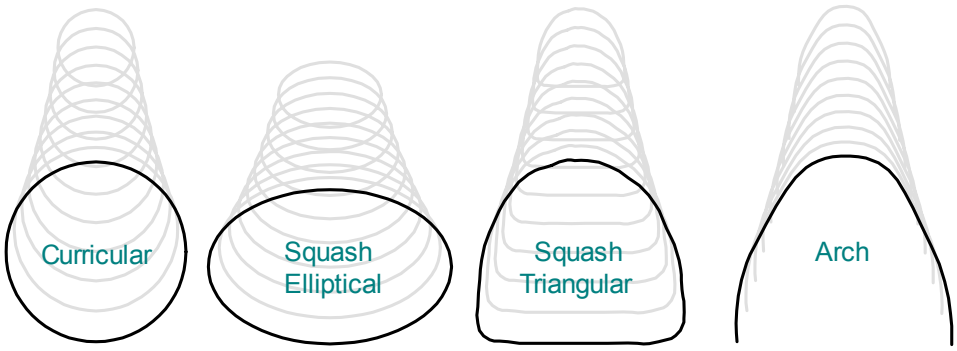
Velocity (time_____) **OR** ft/sec_____

Depth of water in culvert at thalweg _____(In.) Maximum scour elevation _____ (In.)

Type of culvert: Metal _____ Plastic _____

Culvert interior: Corrugated_____ Smooth_____

Culvert Cross Section



Size of Culvert: Height (max)_____(In.) Width (max)_____(In.)

Culvert Outlet Perch Height _____ (In.)

Outlet Pool: Length_____(Ft.) Mean Thalweg Depth _____ (In.)

Swimming Obstructions in outlet pool (Yes / No)

Culvert Verification Checklist

***Forester*_____**

Crossing # (Sec, Tn, Rng, Unique)	Date Checked	Measurements Taken	Pass	Fail	Stream > 25%	If failed, note which number it fails at

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Appendix R-7

Road Abandonment Criteria

Roads that meet **all** of the following conditions can be declared Abandoned under the NFHCP:

1. The road is physically blocked to vehicles.

2. Bridges and stream culverts are removed. Fills leading to the stream crossing are pulled back from the stream and the slope angle re-contoured such that it mimics the natural slopes above and below the crossing. All exposed soils are grass seeded, fertilized (as necessary), and mulched.

3. Road fills are stable. Where perched fills exist, partial or total re-contouring will be utilized to pull back the perched portion and place it on the inside of the road prism or end-hauled to a safe location.

4. Ditches are left in a suitable condition to reduce erosion, and continuous ditch runs do not exceed 100 feet.

5. The road tread is outsloped, water barred, or otherwise left in a condition suitable to control erosion and maintain water movement. Where the tread is flat, the road is waterbarred at a maximum 100-foot interval.

6. Waterbars or drainage features are located such that accumulated surface water from seeps or springs in the cutslope are passed across the road prism and returned to the forest floor as close to the point of origin as reasonably practicable.

7. Road tread, cutslopes, and fillslopes are vegetated, or have been grass seeded. If necessary to promote grass establishment, the road tread has been scarified.

8. As needed, Washington DNR or Idaho Department of Lands approval has been received, and any additional administrative requirements have been met.

9. The intent is that the road will be removed from the transportation system and will not be used again.

When a forester believes that a deviation from one or more criteria listed above would result in less overall impact or risk, a site-specific abandonment plan must be submitted to a Plum Creek hydrologist and/or fish biologist for approval prior to abandonment.