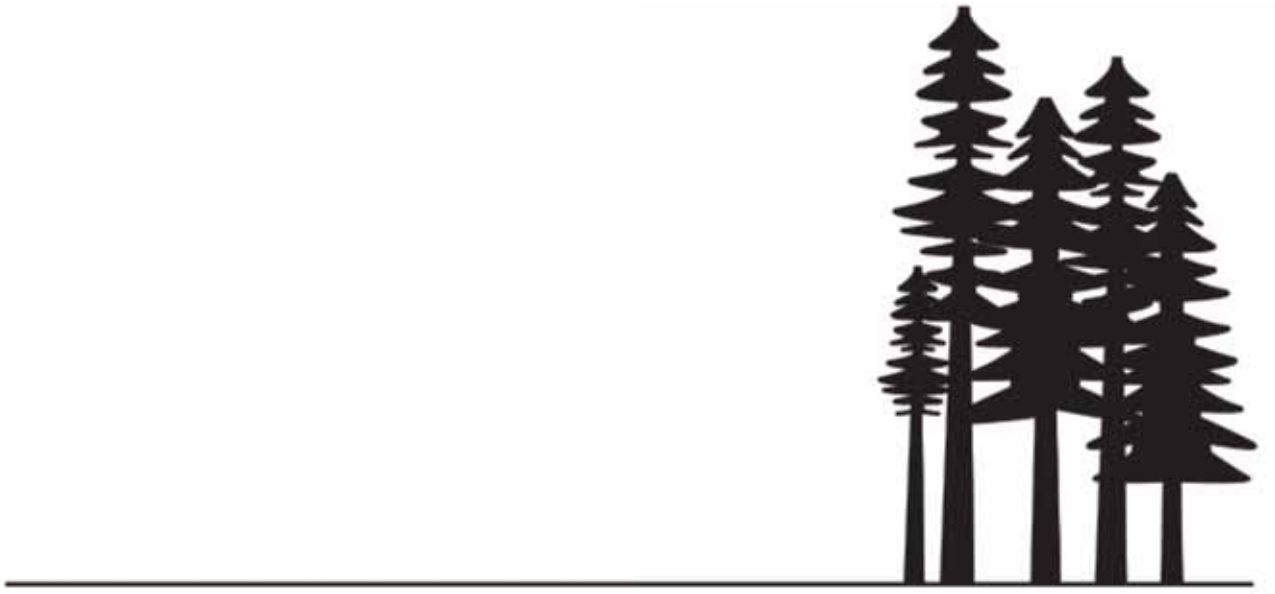


Appendix I. Water

This appendix provides supplemental material for the topics discussed within the chapters of this draft environmental impact statement that are related to water resources and riparian areas that are on BLM-administrated lands.

In this appendix:

Water Planning Criteria

Analytical Question # 1

How do the alternatives affect peak flow estimates that exceed detection limits within the rain dominated hydroregion?

Analytical Assumptions

- Hydroregions are a physical classification of landscapes based on the form of precipitation with elevation, as predominantly rain, rain and snow, or snow. In the rain dominated hydroregion, removal of basal area is used as a surrogate for reductions in leaf area. Removal of basal area is expected to affect peak flows to varying degrees (Grant et al 2007 In Review).
- Ziemer (1981, 1998) found a non-statistical increase (4%) in peak flow for 80 year old conifer stands that were harvested where, 50% of the basal area was retained.
- Within the rain dominated hydroregion the effect of increased peakflow is roughly proportional to area cut. Patch size or arrangement is not a factor in explaining greater flow volume or differences in timing. In this analysis, 40% basal area removed is set as a 6th field watershed response threshold for events with return periods of >2years, where the percent change in peakflow is expected to be greater than the detection limit (Grant et al 2007 In Review).
- Research indicates the largest percent increases in peak flows apply to 100% regeneration harvested watersheds where all the basal area is removed, within the rain dominated hydroregion. For partial reductions in basal area by thinning, the inter-relationships of forest tree size, stocking, distribution and age affect leaf area, but not necessarily hydrologic processes. The 6th field watershed response threshold of 40% basal area removed, will be calculated by using the following assumptions:
- For BLM lands, the 10-year projection derived data layers will be used as a surrogate to determine basal area removed, using the acres of the ecology description attributes of stand establishment with legacy and stand establishment without legacy. For other lands, acres of less than 30% vegetative crown closure reclassed from the 1996 Interagency Vegetation Mapping Project TM will be used as a surrogate for removal of basal area. Any cell meeting this description is binned as basal area removed.
- For other lands, it is assumed that the percentage of basal area removed is the same for all planning time periods by 6th field watershed.
- This analytical procedure is viewed as a screening process to determine probable watersheds at risk for peak flow enhancement from removal of basal area in the precipitation dominated hydroregion. The output changes, depending on the climate, elevation and forest cover relationships.

Analytical Methodology and Technique

The technique relies on ARC GIS processes for analyzing spatial data. Logical and mathematical operations will be written as scripts, based on watershed analysis methodologies.

Step 1 –
Using the Hydroregions derived data layer (Planning Criteria #2 step 3), exclude any 6th field watersheds from further analysis that contain < 70% rain dominated areas. Mask the area of the remaining 6th filed watersheds that are not rain dominated. Build a new selected set labeled "Rain Dominated".

Step 2 –
For other lands, determine "Existing Condition Hydrologic Maturity" for forest vegetation by reclassing the 1996 classified Interagency Vegetation Mapping Project TM (IVMP) imagery. Table 258 will be used to construct the derived data layer.

Table 258. Vegetation Hydrologic Maturity Assignment to Land Cover Class.

Hydrologic Maturity	Land Cover Classes
Minimum Hydrologic Maturity	<30% total crown closure

Step 3 –
Intersect "Current Condition Hydrologic Maturity" (step 2) with the Rain Dominated 6th field watersheds selected set (step 1). Intersect the alternatives' 10-year projections vegetation structural stages with the Rain Dominated 6th field watersheds selected set (step 1).

Step 4 –
For BLM, use the alternatives' 10-year projections, to calculate the acres of basal area removed. Include the stand establishment ecology polygons (acres), with the attributes stand establishment with legacy and stand establishment without legacy for each rain dominated 6th field watershed.

Step 5 –
For other lands, calculate the acres of each rain dominated 6th field watershed that is minimum hydrologic maturity (step #2, Table 258).

Step 6 –
Sum the total basal area removed in acres, by each 6th field watershed, for the existing condition and each alternative (steps 4 and 5). Calculate total 6th field watershed acres, and basal area removed as a percent of the total.

Step 7 –
Conduct reference analysis. Replace the alternatives' 10-year projections coverage with the same attributes in step-4 with the no harvest and maximum harvest on commercial forest lands projections.

Analytical Conclusions

Rank the precipitation dominated 6th field watersheds that exceed 40% basal area removed as sensitive for peak flow increase.

Data Needs

- Classified 1996 imagery from the Interagency Vegetation Mapping Project TM (IVMP), including new openings under 10 years of age, current to 2005.
- GIS-derived data layer of hydroregions.
- GIS-derived data layer of vegetation hydrologic maturity.
- Watershed GIS coverage (for determining area and 6th field watersheds)
- By alternative, GIS-derived spatial data layer of 10-year projections stand establishment (acres).

Data Display

- Figure showing 6th field watersheds where basal area removed exceeds 40%, for the existing condition and with the application of each alternative's 10-year projection.

Analytical Question # 2

How do the alternatives affect peak flow estimates that exceed detection limits within the rain-on-snow hydroregion?

Analytical Assumptions

- Hydroregions are a physical classification of landscapes based on the form of precipitation with elevation, as predominantly rain, rain and snow, or snow. Rain-on-snow areas where shallow snow accumulations can come and go have been reported by Harr (1981, 1992) to be in the elevation range of 1200-3600 feet in western Oregon and from 2500 to 5000 feet in the southern Oregon Cascades (Lindell, pers.com.).
- The subwatershed level (USGS Sixth-field Hydrologic Unit Code) was chosen for the analysis, because it better approximates the BLM forest land pattern, and tributary streams are more sensitive to vegetation and runoff-related changes. This analysis level can also be viewed as an additional margin of safety in terms of describing effects.
- Forest openings commonly receive greater snow accumulation (2 to 3 times more snow water equivalent) than adjacent forests (Harr 1992). These openings also receive greater wind speeds and twice the amount of heat during rain-on-snow events, which provides greater melt compared to the mature forest (Harr 1981, 1992;

Storck 1997). Regeneration harvest or forest conversion will provide additional melt contributions under rain-on-snow conditions (Harr 1981, Storck 1997).

- Rain-on-snow occurrences normally correspond with a streamflow return period of 2 to 8 to years where pre-logging and post-logging regressions were significantly different (Harr 1992).
- Basin characteristics regression analysis with gauged watersheds of long-term record is an appropriate method of describing peak flows of various exceedance probabilities for unregulated streams in ungauged watersheds. Harris and Hubbard (1979) flood frequency equations were chosen as reference points; because they cover the various hydrologic regions in the plan area and have long-term records (10-70 years). The base period of streamflow data collection for use in the analysis was prior to maximum forest conversion in many watersheds. The data set may include some chance rain-on-snow events.
- The 2-year, 24-hour precipitation intensity is assumed to coincide with the 2-year, 24-hour discharge.
- U.S. Army Corps of Engineers studies (USACE 1956, 1998) show that the principal melt component in a rain-on-snow event is convection/condensation melt. This component is far larger than long-wave and short-wave radiation melt, rain melt, and ground melt. In a typical USACE rain-on-snow example, convection/condensation melt accounts for 70 percent of daily snowmelt quantities. Ground wind speed, warm air temperatures and nearly equivalent dewpoint temperatures are the drivers in the convection/condensation melt term.
- Basin characteristics regression analysis with gauged watersheds of long-term record is an appropriate method of describing peak flows of various exceedance probabilities for unregulated streams in ungauged watersheds. Harris and Hubbard (1979) flood frequency equations were chosen as reference points; because they cover the various hydrologic regions in the plan area and have long-term records (10-70 years). The base period of streamflow data collection for use in the analysis was prior to maximum forest conversion in many watersheds. The data set may include some chance rain-on-snow events.
- For other lands, it is assumed that the percentage of basal area removed is the same for all planning time periods by 6th field watershed.
- This analytical procedure is viewed as a screening process to determine probable watersheds at risk for peak flow enhancement from rapid melt of shallow snowpacks. The output changes, depending on the climate, elevation and forest cover relationships.

Analytical Methodology and Technique

The technique relies on ARC GIS GRID processes for analyzing spatial data. Logical and mathematical operations were written as scripts, based on watershed analysis methodologies. The analytical technique is an empirical approach patterned in part from the Washington State Department of Natural Resources Standard Methodology for Conducting Watershed Analysis 1997, (v. 4.0), Appendix C.

Step 1 -
Construct "Flood-Frequency Precipitation" data layer. Obtain precipitation frequency data for the 2-year 24-hour storm for the plan area (NOAA 1973) in raster format available online: [http://www.nws.noaa.gov/ohd/hdsc/noaaatlas2.htm]

Step 2 -
Intersect watershed boundaries with "Flood-Frequency Precipitation" data. Intersect the BLM watershed GIS theme with the flood-frequency precipitation derived data layer at the 6th-field HUC level.

Step 3 -
Determine "Hydroregions." Construct a derived data layer to include elevation bands of rain-dominated areas that are below the rain-on-snow zone; rain-on-snow zone (also called transitional) and snow-dominated zone that are above the rain-on-snow zone. District hydrologists will assign lower and upper elevation bounds for the rain-on-snow zone for all 6th-field watersheds wholly or partly contained in the plan area, based on the following criteria:

Lower Bounds of the Rain-On-Snow Zone

Use National Resources Conservation Service SNOWTEL data for January 1 snow accumulation elevation (Greenburg and Welch 1998), and local hydrologist observation, which may vary from 1200-2500 feet.

Upper Bounds of the Rain-On-Snow Zone

Use regionally established upper limit from hydrologist observation or literature or the onset of frozen soils, which may vary from 3600-5000 feet.

Step 4 -
Filter the "Hydroregions" derived data layer. Filter by 6th-field watershed, and exclude any subwatersheds from further analysis that contain only rain areas or only permanent snow areas or <10% rain-on-snow (transitional) areas. Make a new derived data layer labeled "Rain-on-Snow" selected from the set.

Step 5 –
Using the Rain-on-Snow selected set to separate the remaining 6th field watersheds by flood region (Harris and Hubbard 1979), online: [http://water.usgs.gov/software/nff_manual/or/oregon_AFrame_3.gif]

Step 6 -
Calculate 2-Year 24-Hour Streamflow, and the 5-Year 24-Hour Streamflow from USGS basin characteristics regression analysis method (Harris and Hubbard 1979) using GIS scripts.

2-Year 24-Hour Streamflow

Coast Region: $Q_{0.5}=4.59A^{0.96}(ST+1)^{-0.45}I^{1.91}$

Willamette Region: $Q_{0.5}=8.70A^{0.87}I^{1.71}$

Rogue-Umpqua Region: $Q_{0.5}=24.2A^{0.86}(ST+1)^{-1.16}I^{1.15}$

High Cascades: $Q_{0.5}=4.75A^{0.90}(ST+1)^{-0.62}(101-F)^{0.11}I^{1.17}$

where: $Q^{0.5}$= discharge in cubic feet per second (CFS) for a 2-year 24-hour recurrence interval event:

A = drainage area in square miles

ST = area of lakes and ponds in percent

F = forest cover in percent

I = 2-year 24-hour precipitation intensity in inches

5-Year 24-Hour Streamflow

Coast Region: $Q_{0.2}=6.27A^{0.95}(ST+1)^{-0.45}I^{1.95}$

Willamette Region: $Q_{0.2}=15.6A^{0.88}I^{1.55}$

Rogue-Umpqua Region: $Q_{0.2}=36A^{0.88}(ST+1)^{-1.25}I^{1.15}$

High Cascades: $Q_{0.2}=8.36A^{0.86}(ST+1)^{-0.81}(101-F)^{0.08}I^{1.30}$

where: $Q^{0.2}$= discharge in cubic feet per second (CFS) for a 5-year 24-hour recurrence interval event,

A = drainage area in square miles

ST = area of lakes and ponds in percent

F = forest cover in percent

I = 2-year 24-hour precipitation intensity in inches

Area of lakes and ponds include natural lakes, ponds, and impoundments. Forest cover is the watershed area greater than 10% forest cover, and is the hydrologic maturity cover classes A and B (step 7).

Step 7 –
Determine "Existing Condition Hydrologic Maturity" for forest vegetation, by reclassing the 1996 classified Interagency Vegetation Mapping Project TM (IVMP) imagery. The table below will be used to construct the derived data layer.

Table 259. Vegetation Hydrologic Maturity Assignment to Land Cover Class.

	Hydrologic Maturity	Land Cover Classes
A	Hydrologically Mature	>70% total crown closure AND <75% of the crown in hardwoods or shrubs
B	Intermediate Hydrologic Maturity	10%-70% total crown closure AND <75% of the crown in hardwoods or shrubs
C	Minimum Hydrologic Maturity	<10% total crown closure AND/OR >75% of the crown in hardwoods or shrubs
D	Non-Forested	Agricultural and Grazing Lands Open Water Lakes, Ponds, Reservoirs Inundated Wetlands Other naturally occurring open areas

Source: Department of Natural Resources, Hydrologic Change Module

Step 8 -
Intersect "Existing Condition Hydrologic Maturity" with the "Rain-on-Snow" 6th field watersheds selected set (step 4).

Step 9 -
Estimate snow depth and snow water equivalent to create an "Estimated Snow-water Equivalent" derived data layer.

Obtain the Topographic Data theme for Rain-on-Snow" 6th field watersheds selected set (step 4) and build a raster (cell) derived data layer.

Solve the following two snow water equivalent (SWE) equations for the topographic data theme by writing scripts (Greenburg and Welch 1998):

Northwest Oregon SWE =0.009*Elevation-21.66 *R

Southwest Oregon SWE =0.006*Elevation-19.53*R

where: SWE = February 1 snow-water equivalent in inches.
Elevation = elevation in feet.
R = snowwater equivalent ratio to adjust for cover types

The division between northwest and southwest Oregon regions (for equations) will be determined by an eastward line following the southern edge of the Siuslaw subbasin in the Coast Range to the southern edge of the Willamette subbasin through the Willamette Valley and the Cascades. The line is formed by watersheds:

Lower Siuslaw River	1710020608
Upper Siuslaw River	1710020601
Upper Coast Fork Willamette	1709000203
Row River	1709000201
Hills Creek Reservoir	1709000105
Upper Middle Fork Willamette	1709000101

Snow water equivalent (SWE) values calculated are assumed to represent snow accumulation in hydrologically mature forests; these must be modified to account for variations in accumulation between different land use/cover types.

Table 260. Vegetation hydrologic maturity and snow water equivalent ratios.

	Vegetation Hydrologic Maturity (step 7)	Snow-water Equivalent Ratio (R)
A	Hydrologically Mature	1
B	Intermediate Hydrologic Maturity	1.5
C	Minimum Hydrologic Maturity	2
D	Non-Forested	2

Populate the two snow water equivalent scripts with the snow-water equivalent ratios (R) for the existing condition for the northwest and southwest Oregon areas using classified IVMP data (Step 7), as seen in the table above.

Step 10 -
Determine One-Day Snowmelt for a 24 hour design storm for the existing condition by writing scripts. This procedure uses equations from the U.S. Army Corp of Engineers (1998).

For heavily forested or partly forested areas (step 7 land cover classes A and B):

$M = (0.074 + 0.007P)(T - 32) + 0.05$

For minimum forest or open areas (step 7 land cover classes C and D):

$M = (0.029 + 0.0084kv + 0.007P)(T - 32) + 0.09$

where: M = snowmelt, in/day
v = wind velocity, miles per hour
P_r = rate of precipitation, in./day
T_a = temperature of saturated air, at 10-feet level, °F
k = basin wind coefficient. Use 0.4 for heavily to partly forested areas (hydrologic maturity land cover classes A, and B), and 0.9 for open areas (hydrologic maturity land cover class C and D).

Calculate snowmelt in each hydrologic maturity land cover cell for the existing condition. If the calculated snowmelt (M) for a given scenario exceeds the estimated snow equivalent (SWE), set M = SWE; also, if T_a is ≤ 32 °F, M = 0.

Temperature

Storm temperature varies primarily with elevation. Determine the average storm temperature (Ta °F) for each cell area based on generalized regional lapse-rate equations:

Western Oregon = 50 - (.0033 * E)

where: E = elevation in feet

Wind speed

Local wind speed primarily depends on the vegetative cover, with mature forest canopies significantly reducing the wind speed at the interface between the snowpack and the air. Daily average windspeed (mph) with a 50% exceedance rate (% of days) for an average storm for western Oregon will be used. This corresponds to an estimated 15 mph.

Precipitation

Rate of precipitation is calculated, using the 2 year 24 hour precipitation, in. (step 1).

Step 11 –
Calculate water available for runoff.

Perform a zonal mean for each 6th field watershed:

$$M = \frac{A_1M_1+A_2M_2+\ldots A_nM_n}{A_1+A_2+\ldots A_n}$$

where: M = snowmelt, in.
A = area, acres

Calculate water available for runoff for the existing condition by:

WAR = M + P

where: WAR = water available for runoff, in./day
M = snowmelt, in./day
P = 2-year 24-hour precipitation, in.

Add the snowmelt (M) to the 2-year 24-hour precipitation (P) and track for each 6th-field watershed in the 'Rain-on-Snow" derived data layer (step 4).

Step 12 –
Estimate peak flow for the existing condition. Estimate peak flows for each 6th field watershed (filtered set, step 4) by substituting the water available for runoff value (step 11) for the existing condition into the 2-year 24-hour streamflow regression equations (step 6) for the precipitation term. Compare the result with the 5-year 24-hour streamflow and indicate where it is exceeded.

Step 13 –
Estimate peak flow for the alternatives. Repeat steps 7 to 12 for the 10-year projection by reclassing the expected condition of vegetation (step 7). Intersect the ecology stand establishment with attribute without legacy from the Options model derived data layer for the 10-year projection for each alternative with the "Existing Condition Hydrologic Maturity" for forest vegetation. Substitute cover class C for these areas.

Step 14 –
Conduct reference analysis. Replace the alternatives 10-year projections with the no harvest and maximum harvest on commercial forest lands reference analysis derived data layers. Order the analysis as in step 13.

Step 15 –
As a sensitivity analysis for the design storm, one standard error of the estimate will be applied to the USACE snowmelt equation for temperature and wind speed. For temperature, use 55 - (.0033 * E), where E = elevation in feet. For windspeed, use 25 mph. Modify scripts and rerun the analysis.

Analytical Conclusions

- Rank those subwatersheds that exceed the 5-year 24-hour peakflow as sensitive for estimated peak flow increase.

Data Needs

- National Oceanic and Atmospheric Administration (NOAA) 2-year 24-hour Precipitation Frequency map of Oregon. Available in GIS raster format online: [http://www.nws.noaa.gov/ohd/hdsc/noaaatlas2.htm]
- USGS Flood Regions. Available in GIS raster format online: [http://water.usgs.gov/software/nff_manual/or/oregon_AFrame_3.gif]
- U.S. Weather Service Windspeed Frequency.
- Classified 1996 imagery from the Interagency Vegetation Mapping Project TM (IVMP), including new openings under 10 years of age, existing to 2005.
- GIS-derived data layer of hydroregions.
- GIS-derived data layer of vegetation hydrologic maturity.
- GIS-derived data layer of snow-water equivalent.
- GIS-derived data layer of snowmelt.
- Topography GIS coverage.
- Watershed GIS coverage.
- Waterbodies GIS coverage.
- By alternative, GIS derived data layer of 10-year projection stand establishment.

Data Display

- Figure of hydroregions for the plan area.
- Figure showing 6th-field subwatersheds where the 2-year 24-hour peakflow exceeds the 5-year 24-hour peakflow for the existing condition, for each alternative's 10-year projection.

Analytical Question #3

How will the alternatives affect road sources of fine sediment delivery to stream channels?

Analytical Assumptions

This analysis is based on use of a reference road. The analytical technique is an empirical approach patterned in part from the Washington State Department of Natural Resources Standard Methodology for Conducting Watershed Analysis 1997, (v. 4.0), Appendix B.

The reference road will use the following assumptions: An in-sloped road with a ditch; moderate traffic (pickups sedans, and log haul <50% of the time); cut-slope gradient 1:1 (horizontal to vertical) and fill-slope gradient 1.5:1; initial ground cover density of zero on cut and fill slopes; sustained grade of 5-7 percent; and an average cross-drain spacing of 500 feet.

Proportions of the total long-term average road erosion rates attributed to the components of the standard road prism (Swift 1984, Burroughs and King 1989, Sullivan and Duncan 1980, Megahan unpublished data) are:

- Road Tread 40%
- Cutslope and Ditch 40%
- Fillslope 20%

Roads differ in their inherent erodibility, or erosion potential, due to the geology, or parent material on which they are constructed as seen in Table 261. Sediment yields from older roads with undisturbed ditches are much smaller than sediment yields from newer roads or roads with disturbed ditches. Maintenance of ditchlines can increase sediment yields.

Table 261. Basic Erosion Rates.

		Road Age	
General Category	Geologic Parent Material	New 0-2 Years	Old > 2 Years
High	Mica schist, Volcanic ash, Highly weathered sedimentary	110	60
High/Moderate	Quartzite, Course-grained granite	110	30
Moderate	Fine-grained granite Moderately weathered rock Sedimentary rocks	60	30
Low	Competent granite, Basalt, Metamorphic rocks, Relatively unweathered rocks	20	10

(Note: Numbers represent erosion rates in tons/acre of road prism/year.)

Sources: Kochendorfer, J. N. and J. D. Helvey 1984; Hayden et al. 1991; Megahan and Kidd 1972; Reid and Dunne 1984; Sullivan and Duncan, U.S. Forest Service unpublished data.

The basic erosion rate for road erodibility is decreased by vegetative cover and surface roughness on cut and fills slopes. Table 262 shows reduction factors from the basic erosion rate.

Table 262. Groundcover Correction Factor for Cut and Fill Slopes

Ground Cover Density Factor	Factor
>80%	0.18
50%	0.37
30%	0.53
20%	0.63
10%	0.77
0%	1.00

Sources: Megahan 1991, Burroughs and King 1989, Megahan unpublished data.

The basic erosion rate for road erodibility is decreased by road tread surfacing. Table 263 shows reduction factors based on types of surfacing.

Table 263. Factors for Road Tread Surfacing.

Surfacing Material Factor	Factor
Paved	0.03
Gravel, greater than 6 inches deep	0.2
Native soil/rock	1.00

The basic erosion rate for road erodibility is increased by road traffic and wet weather haul on natural surface and gravel roads. Table 264 shows erodibility increase factors based on precipitation bands and traffic level.

Table 264. Traffic and Precipitation Factor.

	Annual Precipitation		
Traffic Use/Road Category	<47 inches	47 inches – 118 inches	>118 inches
Heavy Traffic/Active Mainline	20	50	120
Moderate Traffic/Active Secondary	2	4	10
Light Traffic/Non Active	1	1	1

Sources: Reid and Dunne 1984; Sullivan and Duncan unpublished

Sediment Delivery

- Sediment delivery to streams is affected by the road drainage system design including road prism shape, proximity of the road to the stream channel, and length of road draining directly into a stream at crossings.
- Sediment delivery to streams by road segment: Assume that a road segment does not deliver if the road does not cross a stream channel.
- Sediment delivery to streams by ditches: Assume 100% delivery of sediment to streams from the road prism and cutslope before application of factors.

- Sediment delivery to streams by diffuse sources: Assume 10% delivery of sediment to streams from the cutslope before application of factors.
- Best Management Practices can substantially reduce sediment delivery from roads.

Sediment Delivery Distance

- Roads near ridges have little direct effect on sediment delivery to streams.
- Generalized distances for sediment filtration effectiveness occur much sooner (25-100 feet) for diffuse sources of sediment delivery compared to concentrated sources (200 feet), such as road ditch lines draining into the riparian area (CH2MHill 1999).
- Wemple (1998 cited in Jones et al 2000) found that road segments that have stream connection pathways such as roadside ditches have potential to deliver surface eroded sediment to streams. Road segments not connected to streams by ditch lines or gullies or having more than 25 to 100 feet of filtering forest floor duff and vegetation (depending on slope, soil properties, and surface roughness) between them and a stream are usually not at risk of delivering sediment to streams.
- Below culverts, sediment travel distance in streams decreases with increasing roughness, such as debris and obstructions (Brake et al. 1997).
- Concentrated and diffuse sources of sediment delivery in this analysis are assumed to be within 200 feet of stream channels.

Road Traffic

- Frequent heavy truck traffic can grind resistant road surfacing such as gravels into smaller particles that can wash into ditchlines during rainstorms. Material type, traffic level and rate determine the quantity of sediment available for transport, while the rainfall determines the transport capacity (Reid and Dunne 1984).

Analytical Methodology and Technique

The technique relies on ARC GIS GRID processes for analyzing spatial data. Logical and mathematical operations were written as scripts, based on watershed analysis methodologies. The analysis is performed by fifth-field watersheds within the plan area.

Step 1 -
Build a basic erosion rate (BER) data layer from the BLM GIS Geology theme by matching the parent materials in the Table 261 Basic Erosion Rates, to the theme mapped designations with input from Geologist and Soil Scientist.

Step 2 -
Build a derived data layer labeled "Streams" from the BLM GIS Watercourses data theme that includes all intermittent and perennial streams.

Step 3 -
Buffer the Streams derived data layer (Step 2) to 200 feet and make a new derived data layer labeled "Sediment Delivery Buffer".

Step 4 -
Intersect and clip BLM GIS GTRN (roads) data theme with the sediment delivery buffer derived data layer (step 3) for all lands. Label new derived data layer "Stream Proximity Roads".

Step 5 –
Refine the stream proximity roads derived data layer (step 4) and exclude road segments that do not cross stream channels. Road segment origin must be further than 30 feet from streams to be excluded.

Step 6 -
Build a table of specific vegetative correction factors by fifth-field watershed using Table 262 Groundcover Correction Factor for Cut and Fill Slopes.

Step 7 -
Use selected Prism Climate Model outputs to build a derived data layer labeled "Average Annual Precipitation" by fifth-field watershed. From the Oregon Climate Service PRISM Products page, online: [http://www.ocs.orst.edu/prism/products/] select the 30-arcsec (800m) normal grids for precipitation for the period 1971-2000.

Step 8 -
Calculate the traffic factor from Table 261, Traffic and Precipitation Factors by intersecting the precipitation dominated and rain-on-snow hydro region (from peakflow planning criteria) with the average annual precipitation data layer (step 7) and develop a new data layer labeled "Traffic factors." Classify into three precipitation bands: <47", 47-118" and >118" from Table 264. Assign traffic factors for moderate traffic where <47" equal 2, 47-118" equal 4, and >118" equal 10.

Step 9 –
For each road segment, add attributes to the data tables for the stream proximity roads derived data layer selected set (step5). Calculate the road segment lengths by surface type within the BLM GIS GTRN roads data layer for BLM and other ownerships and add to the data tables. BLM includes BLM controlled roads and private roads in the planning area from BLM GIS GTRN (roads) theme.

Step 10 -
For each road segment within the stream proximity roads derived data layer selected set (step5) build a logical calculation sequence as scripts to determine potential sediment delivery from the cut slope, road tread and fill slope (calculations 1, 2 and 3) by:

Existing Condition

Return basic erosion rate (BER) value from the basic erosion rate derived data layer of > two year old road age (step 1).

Return road surface type factor (RST) (from Table 178).

Return ground cover density (GCD) factor (step 6).

Return traffic factor (TF) (step 8).

Calculate:

1 [BER * PCD * GCD] * [((cutslope width) + (ditch width) + (road prism width - road tread width / 2)) * road length]/ 43560

2 *where RST = 0.03:* [BER * RT * road surface type factor * [road tread width * road length]/43560

else: [BER * RT * RST] * [TF] * [road tread width * road length]/43560

3 [(BER * FS * GCD) * 0.10] * [((fillslope width) + (road prism width - road tread width / 2)) * road length]/43560

Sum 1, 2 and 3.

Alternative 10 Year Projection

Repeat existing condition calculation except:

Step 1,
Table 258. Return basic erosion rate (BER) value from the basic erosion rate derived data layer of < 2 year old road age.

Step 9.
Calculate the road segment lengths for permanent aggregate and natural surface road for the 10 year projection. No paved roads are planned.

Develop a ratio:

$$\frac{\text{length of road in the sediment delivery buffer (step 3)}}{\text{length of road in the 10 year projection sample}}$$

Multiply this ratio by:

Table 265. Projected Permanent Roads by Alternative[1]

Alternative	Rocked Roads (miles)	Natural Roads (miles)
No Action	250.31	94.49
Alternative 1	384.98	128.44
Alternative 2	494.55	109.64
Alternative 3	393.66	131.95

[1] Based on Dave DeMoss road construction estimates for timber volume per foot of road for sum of regeneration harvests, thinning and partial cuts for all districts.

Develop a ratio:

$$\frac{\text{potential sediment delivery in the sediment delivery buffer}}{\text{length of road in the sediment delivery buffer (feet)}}$$

Multiply this ratio by the adjusted road length. Convert to potential sediment delivery; tons/mile/year.

Step 11 –
Calculate data for display table.

Sum miles of stream proximity roads (inside the sediment delivery buffer) for each Alternative by surface type; paved, aggregate and natural for BLM and other land ownerships for each watershed. Sum all watersheds.

Calculate potential sediment delivery for each alternative in tons per mile of road by surface type: paved, aggregate and natural for BLM and other land ownerships for each watershed. Sum categories for all watersheds.

Calculate potential sediment delivery in tons mile^2/year for BLM and other land ownerships for each watershed. Sum potential sediment delivery for all watersheds for BLM and other land ownerships and divide by the respective landbase.

Table 266. Factor definition table.

Factor	**Factor Definition**
BER	Basic erosion rate in tons/acre/year
PCD	Proportion of cutslope and ditch erosion to the roaded cross section; 0.40
RT	Proportion of road tread erosion to the roaded cross section; 0.40
FS	Proportion of fill slope erosion to the roaded cross section; 0.20
GCD	Groundcover density factor (0.18-1.0)
RST	Road surface type factor; 0.03 paved, 0.2 gravel and 1.0 native surface
TF	Traffic factor within precipitation dominated area for annual precipitation <47 inches equal 20, 47-118 inches equal 50 , >118 inches equal 120
Cut slope width	Cut slope width in feet; generalized 15 feet
Ditch width	Ditch width in feet; generalized 3 feet
Road tread width	Road tread width in feet; generalized 14 feet
Road prism width	Road prism width in feet; generalized 20 feet
Fill slope width	Fill slope width in feet; generalized 10 feet
Road length	Road length in feet, up gradient of stream crossings to the buffer limit
43560	Factor to convert ft^2 to acres

Analytical Conclusions

- Rank of alternatives by their effect on road sources of fine sediment delivery to stream channels.
- Comparison of sediment delivery to that which occurs under the existing condition.

Data Needs

- Proposed new road 10-year projection, by alternative.
- GIS derived data layer of basic erosion rate.
- GIS derived data layer of stream proximity roads derived data layer for the existing condition.
- GIS derived data layer of stream proximity 10-year projection roads for each alternative.
- Prism Model of average annual precipitation for the precipitation hydro region.

Data Display

Populate the following table:

Table 267. Potential sediment delivery, by Alternative from roads.

Alternative	Roads Contributing to Sediment Delivery[2] miles		Potential Sediment Delivery[3] tons/mile/year		Potential Sediment Delivery[4] tons/mile[2]/year	
Existing[1]	BLM	Other	BLM	Other	BLM	Other
Natural						
Aggregate						
Paved						
Total						
No Action New Roads, 10-year projection	BLM		BLM		BLM	
Natural						
Aggregate						
Paved						
Total						
Alternative 1 New Roads, 10-year projection						
Natural						
Aggregate						
Paved						
Total						
Alternative 2 New Roads, 10-year projection						
Natural						
Aggregate						
Paved						
Total						
Alternative 3 New Roads,10-year projection						
Natural						
Aggregate						
Paved						
Total						

[1] BLM includes BLM controlled roads and private roads in the planning area from BLM GIS GTRN (roads) theme.
[2] Includes road segments within 200 feet of a stream channel.
[3] Averaged per mile of road by surface type for each 5th field watershed and averaged for the planning area.
[4] Potential sediment delivery in tons/year for each 5th field watershed divided by each 5th field watershed area for BLM and other lands and averaged for the planning area.

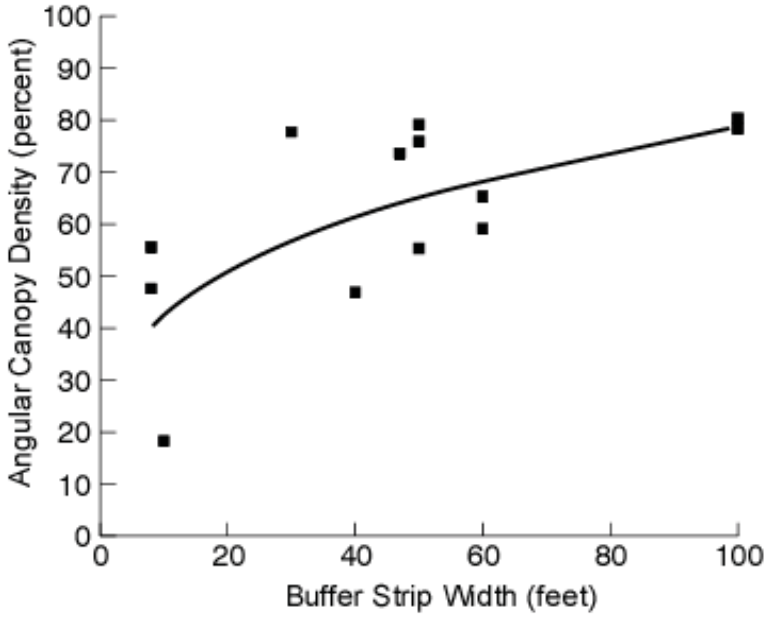
Analytical Question # 4

To what extent will each alternative maintain effective shade along streams, lakes and wetlands?

Analytical Assumptions

- Maintaining streamside shade is a surrogate for meeting the Department of Environmental Quality (DEQ) temperature standard. Northwest Forest Plan Temperature Total Maximum Daily Load (TMDL) Implementation Strategies (2005) demonstrate how retention and variable retention areas meet shade goals and the DEQ temperature standard. These are described as primary and secondary shade zones. The derivation of these zones is based on factors including seasonality of streams, topography, forest vegetation, and solar physics.
- Perennial streams are considered in this analysis, because of the influence that forest shade has on maintaining cool water temperatures during the summer.
- Mountainous topography can block solar radiation through parts of the day along many stream segments.
- Forest trees near stream channels and dense stands can block solar radiation and cast shadows across the stream. Angular canopy density (ACD) is the measure of canopy closure as projected in a straight line from the stream surface to the sun, as it varies through the day. The ACD value for a given buffer depends on the spacing of forest crowns. As vegetation becomes more open through wider spacing, more width of vegetation is needed to achieve the same ACD for the similar vegetation with closer spacing. Higher ACD is achieved with lower sun angles and higher canopy density.

Figure 309. Angular canopy density (ACD) and buffer widths for small streams in western Oregon (Brazier and Brown 1972). It illustrates that a buffer strip width of 60 feet will result in an angular canopy density of 65 percent.



Effective shade is the total amount of radiant energy prevented from reaching a stream in a solar day. Because sun path and azimuth changes throughout the day forest vegetation has different efficiencies in blocking radiation for different time periods. As seen in Figure 312 (below), most solar heating occurs between 10:00 a.m. and 2:00 p.m. Park (1993) has shown that the width of primary riparian streamside areas will vary as a function of tree height and terrain slope as viewed in the Primary Shade Zone Table, included below after Figure 312.

The planning criteria assume the secondary shade zone is defined as the outer edge of the primary shade zone to 100 feet. There is marginal improvement of ACD past 100 feet (Figure 309 above). Significant temperature rises do not occur when effective shade is ≥ 80% (Figures 310 and 311 below).

Figure 310. Angular canopy density (ACD) and stream shade (Park 1991).

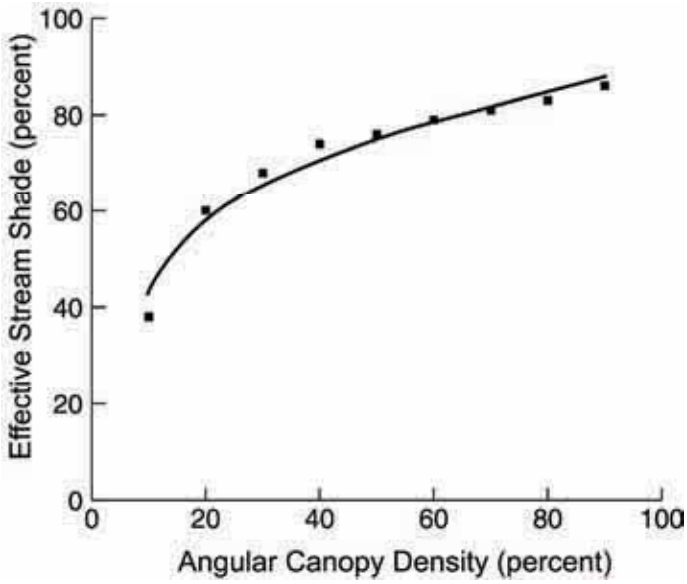


Figure 311. Effective Stream Shade and Change in Stream Temperature

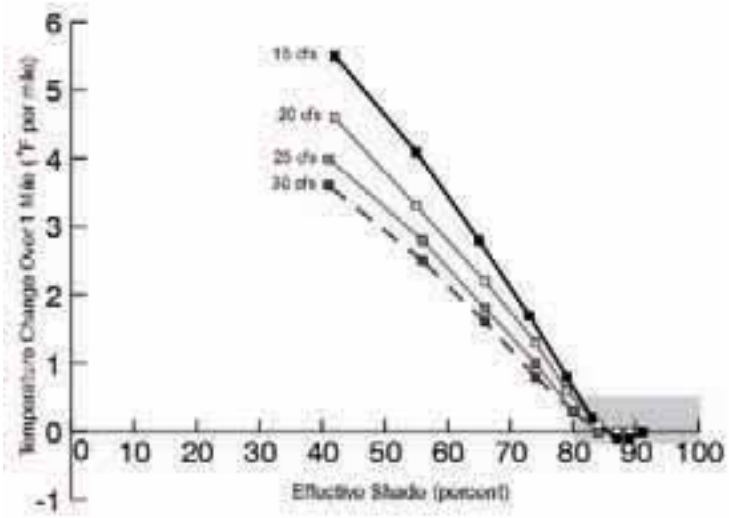


Figure 312. Solar Pathfinder (43° to 49° N Lat., Boyd 1999).

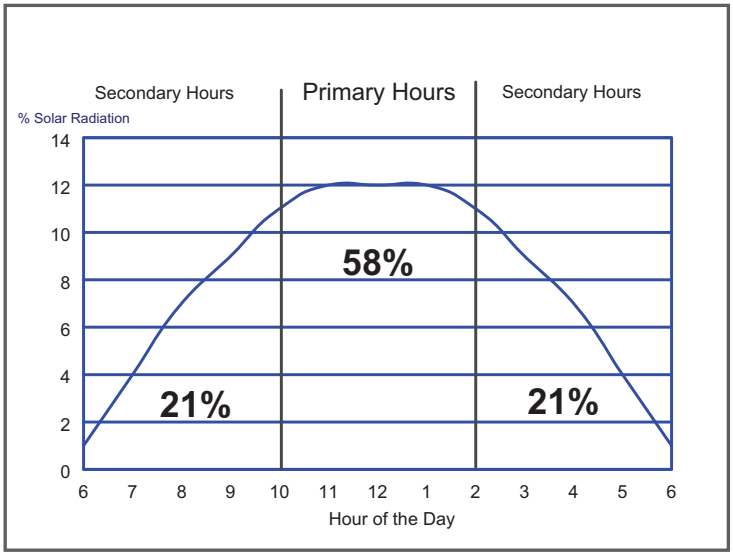


Table 268. Primary Shade Zone Distance of Riparian Trees (In Feet)

height of tree	Hill slope <30%	Hill slope 30 to 60%	HILL SLOPE >60%
Trees < 20 feet	12	14	15 feet
Trees 20 to 60 feet	28	33	55 feet
Trees >60 to 100 feet	50	55	60 feet

Source: Northwest Forest Plan Temperature TMDL Implementation Strategies, 2005.

Forest treatments are assumed to fully meet effective shade and water quality standards within primary and secondary shade zones along streams, lakes, and wetlands when the following criteria are met:

- Table 268 will be used to determine the width of the primary shade zone. Vegetation thinning in the primary shade zone will not result in less than 80% effective shade.
- Vegetation thinning in the secondary shade zone will not result in less than 50% canopy closure post harvest.

For modeling purposes, 60 feet width will be used to define the boundary of the primary shade zone for all combinations of topography and vegetation, and 100 feet will be used to define the boundary of the secondary shade zone.

Analytical Methodology and Technique

Step 1 -
Reclassify the watercourses GIS theme to derive a perennial stream data layer.

Step 2 -
Buffer the perennial streams, lakes, and wetlands to 60 feet. Label this derived data layer "Primary Shade Zone".

Step 3 -
Buffer the perennial streams, lakes, and wetlands to 100 feet.

Step 4 -
Intersect the Primary Shade Zone derived data layer (step 2) with the derived data layer derived (step 3). Label the difference between the Primary Shade Zone and the boundary of 100 feet "Secondary Shade Zone".

Step 5 -
Intersect the Primary Shade Zone with each alternative's primary riparian retention area. Calculate the miles of perennial stream not meeting the primary shade zone.

Step 6 -
Intersect the Secondary Shade Zone with each alternative riparian variable management riparian area that meets 50% canopy closure post harvest. Calculate the miles of perennial stream not meeting the secondary shade zone.

Analytical Conclusion

- Rank of alternatives by the extent that each alternative riparian area meets the primary and secondary shade zones on BLM-managed lands.

Data Needs

- GIS Watercourses data theme
- GIS derived data layer or detailed description of each alternative's full riparian retention and variable retention areas.

Data Display

Table 269. Comparison of Alternatives Not Meeting Effective Shade for Perennial Streams.

Alternative	Perennial Streams Not Meeting Primary Shade Zones (Miles)	% of Total Perennial Stream	Perennial Stream Not Meeting Secondary Shade Zones (Miles)	%of Total Perennial Stream
No Action				
Alternative 1				
Alternative 2				
Alternative 3				

Source Water Watersheds for Public Water Systems

The following table contains a list of source water watersheds for public water systems in the planning area. In many cases, the BLM administers a small portion of the watersheds.

Table 270. Source water watersheds with BLM-administered lands in the planning area.

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100003	ADAIR VILLAGE WATER SYSTEM	WILLAMETTE RIVER		8144	
4100003	ADAIR VILLAGE WATER SYSTEM	WILLAMETTE RIVER			226461
4100003	ADAIR VILLAGE WATER SYSTEM	SUBTOTAL	650	8144	226461
4100152	CITY OF BROWNSVILLE	CALAPOOIA RIVER		5254	
4100152	CITY OF BROWNSVILLE	CALAPOOIA RIVER			94920
4100152	CITY OF BROWNSVILLE	SUBTOTAL	1500	5254	94920
4100157	CANBY UTILITY BOARD	MOLALLA RIVER		2892	
4100157	CANBY UTILITY BOARD	MOLALLA RIVER			84687
4100157	CANBY UTILITY BOARD	SUBTOTAL	12000	2892	84687
4100169	CITY OF CANYONVILLE	CANYON CREEK		13247	
4100169	CITY OF CANYONVILLE	CANYON CREEK			9408
4100169	CITY OF CANYONVILLE	SUBTOTAL	1265	13247	9408
4100171	CITY OF CARLTON	PANTHER CREEK		1070	
4100171	CITY OF CARLTON	PANTHER CREEK			1003
4100171	CITY OF CARLTON	SUBTOTAL	1570	1070	1003
4100187	CLACKAMAS RIVER WATER-CLACKAMAS	CLACKAMAS RIVER		8399	
4100187	CLACKAMAS RIVER WATER-CLACKAMAS	CLACKAMAS RIVER			159669
4100187	CLACKAMAS RIVER WATER-CLACKAMAS	SUBTOTAL	90000	8399	159669
4100199	BEAVER WATER DISTRICT	BEAVER CREEK		1649	
4100199	BEAVER WATER DISTRICT	BEAVER CREEK			17000
4100199	BEAVER WATER DISTRICT	SUBTOTAL	500	1649	17000
4100202	COLTON WATER DISTRICT	JACKSON CREEK		598	

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100202	COLTON WATER DISTRICT	JACKSON CREEK			1536
4100202	COLTON WATER DISTRICT	SUBTOTAL	1200	598	1536
4100213	CITY OF COQUILLE	COQUILLE RIVER		67076	
4100213	CITY OF COQUILLE	RINK CREEK		0	
4100213	CITY OF COQUILLE	COQUILLE RIVER			248930
4100213	CITY OF COQUILLE	RINK CREEK			429
4100213	CITY OF COQUILLE	SUBTOTAL	4300	67076	249359
4100225	CITY OF CORVALLIS	SOUTH FORK ROCK CREEK		52	
4100225	CITY OF CORVALLIS	GRIFFITH CREEK			1051
4100225	CITY OF CORVALLIS	NORTH FORK ROCK CREEK			2155
4100225	CITY OF CORVALLIS	SOUTH FORK ROCK CREEK			3177
4100225	CITY OF CORVALLIS	WILLAMETTE RIVER			40593
4100225	CITY OF CORVALLIS	SUBTOTAL	50101	52	46975
4100236	CITY OF COTTAGE GROVE	LAYING CREEK		80	
4100236	CITY OF COTTAGE GROVE	ROW RIVER		37205	
4100236	CITY OF COTTAGE GROVE	LAYING CREEK			36989
4100236	CITY OF COTTAGE GROVE	PRATHER CREEK			3482
4100236	CITY OF COTTAGE GROVE	ROW RIVER			160279
4100236	CITY OF COTTAGE GROVE	SUBTOTAL	8500	37285	200750
4100239	LONDON WATER CO-OP	BEAVER CREEK		253	
4100239	LONDON WATER CO-OP	BEAVER CREEK			615
4100239	LONDON WATER CO-OP	SUBTOTAL	50	253	615
4100246	CITY OF CRESWELL	COAST FORK WILLAMETTE RIVER		26141	
4100246	CITY OF CRESWELL	COAST FORK WILLAMETTE RIVER			96969
4100246	CITY OF CRESWELL	SUBTOTAL	3380	26141	96969
4100248	CITY OF DALLAS	RICKREAL CREEK		2874	
4100248	CITY OF DALLAS	RICKREAL CREEK			15092

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100248	CITY OF DALLAS	SUBTOTAL	12900	2874	15092
4100250	MILO ACADEMY	LICKEY CREEK		227	
4100250	MILO ACADEMY	SOUTH UMPQUA RIVER		10090	
4100250	MILO ACADEMY	LICKEY CREEK			251
4100250	MILO ACADEMY	SOUTH UMPQUA RIVER			11365
4100250	MILO ACADEMY	SUBTOTAL	195	10317	11616
4100254	CITY OF DEPOE BAY	NORTH DEPOE BAY CREEK		7	
4100254	CITY OF DEPOE BAY	SOUTH DEPOE BAY CREEK		29	
4100254	CITY OF DEPOE BAY	NORTH DEPOE BAY CREEK			521
4100254	CITY OF DEPOE BAY	ROCKY CREEK			3396
4100254	CITY OF DEPOE BAY	SOUTH DEPOE BAY CREEK			2736
4100254	CITY OF DEPOE BAY	SUBTOTAL	1060	36	6653
4100260	CITY OF DRAIN	ALAN CREEK		235	
4100260	CITY OF DRAIN	BEAR CREEK		1133	
4100260	CITY OF DRAIN	ALAN CREEK			415
4100260	CITY OF DRAIN	BEAR CREEK			2235
4100260	CITY OF DRAIN	SUBTOTAL	1145	1368	2650
4100276	CITY OF ELKTON	UMPQUA RIVER		64481	
4100276	CITY OF ELKTON	UMPQUA RIVER			251660
4100276	CITY OF ELKTON	SUBTOTAL	170	64481	251660
4100279	CITY OF ESTACADA	CLACKAMAS RIVER (ESTACADA)		5714	
4100279	CITY OF ESTACADA	CLACKAMAS RIVER (ESTACADA)			341992
4100279	CITY OF ESTACADA	SUBTOTAL	1910	5714	341992
4100287	EUGENE WATER & ELECTRIC BOARD	MCKENZIE RIVER		25805	
4100287	EUGENE WATER & ELECTRIC BOARD	MCKENZIE RIVER			708818
4100287	EUGENE WATER & ELECTRIC BOARD	SUBTOTAL	150,000	25805	708818
4100297	FALLS CITY WATER DEPARTMENT	GLAZE CREEK		360	

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100297	FALLS CITY WATER DEPARTMENT	TEAL CREEK		186	
4100297	FALLS CITY WATER DEPARTMENT	GLAZE CREEK			288
4100297	FALLS CITY WATER DEPARTMENT	TEAL CREEK			2386
4100297	FALLS CITY WATER DEPARTMENT	SUBTOTAL	1045	546	2674
4100301	HECETA WATER DISTRICT	CLEAR LAKE			615
4100301	HECETA WATER DISTRICT	SUBTOTAL	4500		615
4100302	SILTCOOS HEIGHTS	SILTCOOS LAKE		825	
4100302	SILTCOOS HEIGHTS	SILTCOOS LAKE			38863
4100302	SILTCOOS HEIGHTS	SUBTOTAL	125	825	38863
4100317	CITY OF GATES	NORTH SANTIAM RIVER		2624	
4100317	CITY OF GATES	NORTH SANTIAM RIVER			238707
4100317	CITY OF GATES	SUBTOTAL	535	2624	238707
4100323	CITY OF GLENDALE	COW CREEK		37197	
4100323	CITY OF GLENDALE	MILL CREEK		42	
4100323	CITY OF GLENDALE	SECTION CREEK		426	
4100323	CITY OF GLENDALE	COW CREEK			80664
4100323	CITY OF GLENDALE	MILL CREEK			429
4100323	CITY OF GLENDALE	SECTION CREEK			575
4100323	CITY OF GLENDALE	SUBTOTAL		37665	81669
4100324	KERNVILLE-GLENEDEN-LINCOLN BCH W D	DRIFT CREEK		1861	
4100324	KERNVILLE-GLENEDEN-LINCOLN BCH W D	DRIFT CREEK			20376
4100324	KERNVILLE-GLENEDEN-LINCOLN BCH W D	SUBTOTAL		1861	20376
4100326	GLIDE WATER ASSOCIATION	NORTH UMPQUA RIVER		60943	
4100326	GLIDE WATER ASSOCIATION	NORTH UMPQUA RIVER			367586
4100326	GLIDE WATER ASSOCIATION	SUBTOTAL	900	60943	367586
4100333	CITY OF GOLD HILL	ROGUE RIVER		34045	
4100333	CITY OF GOLD HILL	ROGUE RIVER			249777
4100333	CITY OF GOLD HILL	SUBTOTAL	1,115	34045	249777

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100342	CITY OF GRANTS PASS	ROGUE RIVER		69042	
4100342	CITY OF GRANTS PASS	ROGUE RIVER			101888
4100342	CITY OF GRANTS PASS	SUBTOTAL	26,000	69042	101888
4100359	CORBETT WATER DISTRICT	NORTH FORK GORDON CREEK		324	
4100359	CORBETT WATER DISTRICT	SOUTH FORK GORDON CREEK		46	
4100359	CORBETT WATER DISTRICT	NORTH FORK GORDON CREEK			1773
4100359	CORBETT WATER DISTRICT	SOUTH FORK GORDON CREEK			1761
4100359	CORBETT WATER DISTRICT	SUBTOTAL	2910	370	3534
4100379	HILLSBORO-FOREST GROVE-BEAVERTON	NORTH FORK TRASK RIVER (BARNEY RESERVOIR)		600	
4100379	HILLSBORO-FOREST GROVE-BEAVERTON	TUALATIN RIVER		2817	
4100379	HILLSBORO-FOREST GROVE-BEAVERTON	NORTH FORK TRASK RIVER (BARNEY RESERVOIR)			4681
4100379	HILLSBORO-FOREST GROVE-BEAVERTON	TUALATIN RIVER			112489
4100379	HILLSBORO-FOREST GROVE-BEAVERTON	SUBTOTAL	65100	3416	117170
4100408	CITY OF JEFFERSON	NORTH SANTIAM RIVER		30953	
4100408	CITY OF JEFFERSON	NORTH SANTIAM RIVER			223196
4100408	CITY OF JEFFERSON	SUBTOTAL	2245	30953	223196
4100466	LANGLOIS WATER DISTRICT	FLORAS CREEK		3099	
4100466	LANGLOIS WATER DISTRICT	FLORAS CREEK			35926
4100466	LANGLOIS WATER DISTRICT	SUBTOTAL	250	3099	35926
4100473	CITY OF LEBANON	SOUTH SANTIAM CANAL		4508	
4100473	CITY OF LEBANON	SOUTH SANTIAM CANAL			73732
4100473	CITY OF LEBANON	SUBTOTAL	11000	4508	73732

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100483	LINCOLN CITY WATER DISTRICT	SCHOONER CREEK		310	
4100483	LINCOLN CITY WATER DISTRICT	SCHOONER CREEK			9284
4100483	LINCOLN CITY WATER DISTRICT	SUBTOTAL	13527	310	9284
4100493	LYONS MEHAMA WATER DISTRICT	NORTH SANTIAM RIVER		15262	
4100493	LYONS MEHAMA WATER DISTRICT	NORTH SANTIAM RIVER			73059
4100493	LYONS MEHAMA WATER DISTRICT	SUBTOTAL	1670	15262	73059
4100497	MCMINNVILLE WATER AND LIGHT	HASKINS RESERVOIR		691	
4100497	MCMINNVILLE WATER AND LIGHT	MCGUIRE RESERVOIR		20	
4100497	MCMINNVILLE WATER AND LIGHT	HASKINS RESERVOIR			1235
4100497	MCMINNVILLE WATER AND LIGHT	MCGUIRE RESERVOIR			4259
4100497	MCMINNVILLE WATER AND LIGHT	SUBTOTAL	2100	711	5494
4100513	MEDFORD WATER COMMISSION	ROGUE RIVER		69729	
4100513	MEDFORD WATER COMMISSION	ROGUE RIVER			231481
4100513	MEDFORD WATER COMMISSION	SUBTOTAL	83,454	69729	231481
4100520	MILL CITY WATER DEPARTMENT	NORTH SANTIAM RIVER		1594	
4100520	MILL CITY WATER DEPARTMENT	NORTH SANTIAM RIVER			17810
4100520	MILL CITY WATER DEPARTMENT	SUBTOTAL	1800	1594	17810
4100534	CITY OF MOLALLA	MOLALLA RIVER		43125	
4100534	CITY OF MOLALLA	MOLALLA RIVER			86867
4100534	CITY OF MOLALLA	SUBTOTAL	3100	43125	86867
4100548	CLARKS BRANCH WTR. ASSOCIATION	SOUTH UMPQUA RIVER		31450	
4100548	CLARKS BRANCH WTR. ASSOCIATION	SOUTH UMPQUA RIVER			52653
4100548	CLARKS BRANCH WTR. ASSOCIATION	SUBTOTAL	140	31450	52653

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100549	TRI-CITY WATER DISTRICT	SOUTH UMPQUA RIVER		36492	
4100549	TRI-CITY WATER DISTRICT	SOUTH UMPQUA RIVER			70005
4100549	TRI-CITY WATER DISTRICT	SUBTOTAL	3500	36492	70005
4100550	CITY OF MYRTLE CREEK	SOUTH UMPQUA RIVER		424	
4100550	CITY OF MYRTLE CREEK	SPRINGBROOK SPRINGS A		100	
4100550	CITY OF MYRTLE CREEK	SPRINGBROOK SPRINGS B		67	
4100550	CITY OF MYRTLE CREEK	SOUTH UMPQUA RIVER			3804
4100550	CITY OF MYRTLE CREEK	SPRINGBROOK SPRINGS A			187
4100550	CITY OF MYRTLE CREEK	SPRINGBROOK SPRINGS B			228
4100550	CITY OF MYRTLE CREEK	SUBTOTAL	3,460	591	4219
4100551	CITY OF MYRTLE POINT	NORTH FORK COQUILLE RIVER		81975	
4100551	CITY OF MYRTLE POINT	NORTH FORK COQUILLE RIVER			98932
4100551	CITY OF MYRTLE POINT	SUBTOTAL	2715	81975	98932
4100581	CITY OF OAKLAND	CALAPOOYA CREEK		5056	
4100581	CITY OF OAKLAND	CALAPOOYA CREEK			59857
4100581	CITY OF OAKLAND	SUBTOTAL	954	5056	59857
4100603	PANTHER CREEK WATER DISTRICT	PANTHER CREEK		35	
4100603	PANTHER CREEK WATER DISTRICT	PANTHER CREEK			1071
4100603	PANTHER CREEK WATER DISTRICT	SUBTOTAL	550	35	1071
4100624	CITY OF PHILOMATH PUBLIC WORKS	MARY'S RIVER		1084	
4100624	CITY OF PHILOMATH PUBLIC WORKS	MARY'S RIVER			84926
4100624	CITY OF PHILOMATH PUBLIC WORKS	SUBTOTAL	4000	1084	84926

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100657	PORTLAND BUREAU OF WATER WORKS	BULL RUN		60	
4100657	PORTLAND BUREAU OF WATER WORKS	BULL RUN			65523
4100657	PORTLAND BUREAU OF WATER WORKS	SUBTOTAL	831000	60	65523
4100672	CITY OF POWERS	BINGHAM CREEK		16	
4100672	CITY OF POWERS	SOUTH FORK COQUILLE RIVER		234	
4100672	CITY OF POWERS	BINGHAM CREEK			163
4100672	CITY OF POWERS	SOUTH FORK COQUILLE RIVER			93877
4100672	CITY OF POWERS	SUBTOTAL	700	250	94039
4100706	CITY OF RIDDLE	COW CREEK		83338	
4100706	CITY OF RIDDLE	COW CREEK			109130
4100706	CITY OF RIDDLE	SUBTOTAL	1,303	83338	109130
4100707	LAWSON ACRES WATER ASSOCIATION	COW CREEK		2363	
4100707	LAWSON ACRES WATER ASSOCIATION	COW CREEK			4661
4100707	LAWSON ACRES WATER ASSOCIATION	SUBTOTAL	75	2363	4661
4100712	CITY OF ROGUE RIVER	ROGUE RIVER		25273	
4100712	CITY OF ROGUE RIVER	ROGUE RIVER			43689
4100712	CITY OF ROGUE RIVER	SUBTOTAL	2000	25273	43689
4100717	ROBERTS CREEK WATER DISTRICT	SOUTH UMPQUA RIVER			3095
4100717	ROBERTS CREEK WATER DISTRICT	SUBTOTAL	6500	0	3095
4100719	UMPQUA BASIN WATER ASSOCIATION	NORTH UMPQUA RIVER		1214	
4100719	UMPQUA BASIN WATER ASSOCIATION	NORTH UMPQUA RIVER			32269
4100719	UMPQUA BASIN WATER ASSOCIATION	SUBTOTAL	8500	1214	32269
4100720	CITY OF ROSEBURG-WINCHESTER	NORTH UMPQUA RIVER		24682	
4100720	CITY OF ROSEBURG-WINCHESTER	NORTH UMPQUA RIVER			106472
4100720	CITY OF ROSEBURG-WINCHESTER	SUBTOTAL	30000	24682	106472

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100731	SALEM PUBLIC WORKS	NORTH SANTIAM RIVER AND IG		934	
4100731	SALEM PUBLIC WORKS	NORTH SANTIAM RIVER AND IG			16221
4100731	SALEM PUBLIC WORKS	SUBTOTAL	170000	934	16221
4100789	CITY OF SANDY	ALDER CREEK		633	
4100789	CITY OF SANDY	ALDER CREEK			3769
4100789	CITY OF SANDY	SUBTOTAL	5030	633	3769
4100792	CITY OF SCAPPOOSE	GOURLAY		550	
4100792	CITY OF SCAPPOOSE	LAZY CREEK		377	
4100792	CITY OF SCAPPOOSE	SOUTH FORK SCAPPOOSE CREEK		1477	
4100792	CITY OF SCAPPOOSE	GOURLAY			879
4100792	CITY OF SCAPPOOSE	LAZY CREEK			337
4100792	CITY OF SCAPPOOSE	SOUTH FORK SCAPPOOSE CREEK			2413
4100792	CITY OF SCAPPOOSE	SUBTOTAL	3500	2404	3629
4100808	COUNTRY VIEW MH ESTATES	ROGUE RIVER		94370	
4100808	COUNTRY VIEW MH ESTATES	ROGUE RIVER			639475
4100808	COUNTRY VIEW MH ESTATES	SUBTOTAL	112	94370	639475
4100811	CITY OF SHERIDAN	SOUTH YAMHILL RIVER		14950	
4100811	CITY OF SHERIDAN	SOUTH YAMHILL RIVER			120465
4100811	CITY OF SHERIDAN	SUBTOTAL	5200	14950	120465
4100821	CITY OF SILETZ	SILETZ RIVER		13670	
4100821	CITY OF SILETZ	TANGERMAN CREEK		1	
4100821	CITY OF SILETZ	SILETZ RIVER			117918
4100821	CITY OF SILETZ	TANGERMAN CREEK			296
4100821	CITY OF SILETZ	SUBTOTAL	1100	13671	118214
4100823	CITY OF SILVERTON	ABIQUA CREEK		1776	
4100823	CITY OF SILVERTON	ABIQUA CREEK			29894
4100823	CITY OF SILVERTON	SUBTOTAL	5480	1776	29894
4100843	STAYTON WATER SUPPLY	NORTH SANTIAM RIVER		0	

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100843	STAYTON WATER SUPPLY	NORTH SANTIAM RIVER			4537
4100843	STAYTON WATER SUPPLY	SUBTOTAL	5630	0	4537
4100847	CITY OF SUTHERLIN	CALAPOOYA CREEK NON-PAREIL		5055	
4100847	CITY OF SUTHERLIN	COOPER CREEK		480	
4100847	CITY OF SUTHERLIN	CALAPOOYA CREEK NON-PAREIL			49629
4100847	CITY OF SUTHERLIN	COOPER CREEK			2456
4100847	CITY OF SUTHERLIN	SUBTOTAL	6360	5535	52086
4100851	CITY OF SWEET HOME	SOUTH SANTIAM RIVER		31600	
4100851	CITY OF SWEET HOME	SOUTH SANTIAM RIVER			329872
4100851	CITY OF SWEET HOME	SUBTOTAL	7235	31600	329872
4100926	CITY OF WALDPORT	ECKMAN CREEK		40	
4100926	CITY OF WALDPORT	NORTH FORK WEIST CREEK		29	
4100926	CITY OF WALDPORT	ECKMAN CREEK			2756
4100926	CITY OF WALDPORT	NORTH FORK WEIST CREEK			169
4100926	CITY OF WALDPORT	SOUTH FORK WEIST CREEK			193
4100926	CITY OF WALDPORT	SUBTOTAL	3000	69	3118
4100953	CITY OF WILLAMINA WATER DEPARTMENT	WILLAMINA CREEK		15010	
4100953	CITY OF WILLAMINA WATER DEPARTMENT	WILLAMINA CREEK			37480
4100953	CITY OF WILLAMINA WATER DEPARTMENT	SUBTOTAL	1760	15010	37480
4100957	WINSTON-DILLARD WATER DISTRICT	SOUTH UMPQUA RIVER		28316	
4100957	WINSTON-DILLARD WATER DISTRICT	SOUTH UMPQUA RIVER			83243
4100957	WINSTON-DILLARD WATER DISTRICT	SUBTOTAL	6500	28316	83243
4100958	CITY OF YONCALLA	ADAMS CREEK		494	
4100958	CITY OF YONCALLA	ADAMS CREEK			709
4100958	CITY OF YONCALLA	WILSON CREEK			474
4100958	CITY OF YONCALLA	SUBTOTAL	1095	494	1183

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100968	CITY OF YAMHILL	TURNER CREEK		963	
PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4100968	CITY OF YAMHILL	TURNER CREEK			1955
4100968	CITY OF YAMHILL	SUBTOTAL	1500	963	1955
4100971	CITY OF CAVE JUNCTION	EAST FORK ILLINOIS RIVER		15476	
4100971	CITY OF CAVE JUNCTION	EAST FORK ILLINOIS RIVER			107511
4100971	CITY OF CAVE JUNCTION	SUBTOTAL	1,440	15476	107511
4100985	HILLSBORO-CHERRY GROVE	TUALATIN RIVER		952	
4100985	HILLSBORO-CHERRY GROVE	TUALATIN RIVER			14613
4100985	HILLSBORO-CHERRY GROVE	SUBTOTAL	250	952	14613
4101092	USFS TILLER RANGER STATION	USFS TILLER RANGER STATION		10566	
4101092	USFS TILLER RANGER STATION	USFS TILLER RANGER STATION			277963
4101092	USFS TILLER RANGER STATION	SUBTOTAL	1092	10566	277963
4101095	USFS WOLF CREEK JOB CORPS	LITTLE RIVER		2405	
4101095	USFS WOLF CREEK JOB CORPS	LITTLE RIVER			55405
4101095	USFS WOLF CREEK JOB CORPS	SUBTOTAL	250	2405	55405
4101174	BUELL-RED PRAIRIE WATER ASSN	GOOSENECK CREEK		959	
4101174	BUELL-RED PRAIRIE WATER ASSN	GOOSENECK CREEK			98
4101174	BUELL-RED PRAIRIE WATER ASSN	SUBTOTAL	980	959	98
4190416	FORT JAMES OPERATING CO.	COLUMBIA RIVER		819	
4190416	FORT JAMES OPERATING CO.	COLUMBIA RIVER			86153

PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4190416	FORT JAMES OPERATING CO.	SUBTOTAL	750	819	86153
4192139	TILLER ELEMENTARY, SD #15	SOUTH UMPQUA RIVER		386	
4192139	TILLER ELEMENTARY, SD #15	SOUTH UMPQUA RIVER			54592
4192139	TILLER ELEMENTARY, SD #15	SUBTOTAL	60	386	54592
PWS_ID[1]	PWS NAME	SOURCE	POPULATION SERVED	BLM ACRES	OTHER ACRES
4192152	POPE & TALBOT, INC.,	WILLAMETTE RIVER		77011	
4192152	POPE & TALBOT, INC.,	WILLAMETTE RIVER			1167276
4192152	POPE & TALBOT, INC.,	SUBTOTAL	800	77011	1167276
4192674	USFS STAR RANGER STATION	APPLEGATE RIVER		4402	
4192674	USFS STAR RANGER STATION	APPLEGATE RIVER			115722
4192674	USFS STAR RANGER STATION	SUBTOTAL	25	4402	115722
4194300	ROSEBURG FOREST PROD-DILLARD	SOUTH UMPQUA RIVER		3823	
4194300	ROSEBURG FOREST PROD-DILLARD	SOUTH UMPQUA RIVER			25041
4194300	ROSEBURG FOREST PROD-DILLARD	SUBTOTAL	2000	3823	25041

1 Department of Environmental Quality Public Water System identification number for surface drinking water watersheds.

Best Management Practices

Introduction

This section defines the best management practices (i.e., methods and measures) that were developed for the needs of the lands within the western Oregon planning area to comply with the requirements of the Clean Water Act.

Purpose

Best management practices (BMPs) are required by the federal Clean Water Act to reduce nonpoint source pollution to the maximum extent practicable. BMPs are considered the primary mechanisms for achieving Oregon's water quality standards. Oregon's narrative criteria, which include numeric standards, are designed to protect designated beneficial uses (such as salmonid spawning and rearing, resident fish and aquatic life, domestic water supplies, and water-contact recreation).

BMPs are defined as methods, measures, or practices selected on the basis of site-specific conditions to ensure that water quality will be maintained at its highest practicable level. BMPs include, but are not limited to, structural and nonstructural controls, operations, and maintenance procedures. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters (40 CFR 130.2, EPA Water Quality Standards Regulation).

These BMPs are commonly employed practices used in a variety of situations to maintain or improve water quality. Selection of specific BMPs needed to meet the Clean Water Act are made by soil and water professionals during project-level analyses.

Organization and Use

The BMPs in this appendix are organized by the following management activities:

- roads and landings
- timber harvest activities
- silvicultural activities
- fire and fuels management
- surface source water for drinking water
- recreation
- grazing

- minerals exploration and development
- spill prevention and abatement
- restoration

The tables that follow this introduction identify the input variables, causal mechanisms, and water quality standards (referenced by the Oregon Administrative Rules number) that are associated with each BMP. Those BMPs that are necessary for typical situations have been included. When applied, BMPs are expected to prevent water quality degradation and to meet water quality standards.

Causal mechanisms help explain the outcomes or the process through which an outcome occurs.

Narrative criteria

For information about Oregon's water quality standards and narrative criteria, start at http://www.blm.gov/nstc/WaterLaws/oregon2.html.

Resource aspects of land management activities normally have many facets that require site-specific BMP design. Therefore, there may be some repetition of the BMPs between sections of the following tables as some BMPs stand alone while others are used in combination or reference another section in order to address the needs of individual management activities.

Management of locatable minerals is governed by regulations found in 43 CFR 3809. BMPs for locatable minerals include language from 43 CFR 3809 that requires operators to prevent unnecessary and undue degradation from mining operations.

Some BMPs that relate to instream activities involving removal/fill may coincidently be similar to applicable practices in DEQ water quality permits and 401 certifications. These BMPs are not specific permit requirements, but rather demonstrate the process by which nonpoint source pollution from instream activities would be controlled. Appropriate practices in this appendix could be selected by the permitting agencies and included in specific permits or 401 certifications.

Application of Best Management Practices

It is not intended that all of the BMPs listed will be selected for any specific management action. BMPs are selected and implemented as necessary and practical, based on site-specific conditions. BMPs at times require adjustment to meet project and soil conditions within differing climatic and physiographic regions. Specialists may consider baseline environmental conditions, type of activity, proximity to water, disturbance level, direct, indirect, and cumulative effects and timing. Therefore, BMPs may be modified in order to match effective BMP controls to the project design.

Oregon Administrative Rules

For the rules related to water quality standards, search at http://arcweb.sos.state.or.us/banners/rules.htm.

BMPs must be applied in a manner that is consistent with all Resource Management Plan objectives. The overall goal is not to adhere strictly to a particular set of BMPs, but to meet water quality objectives when implementing management actions. Describing non-point pollution causal mechanisms allows specialists to exercise discretion as to what will work best in a particular situation. While this Appendix does not provide an exhaustive list of BMPs, the included BMPs are believed to cover most project activity situations in the Plan area. Additional nonpoint source control measures may be identified during the interdisciplinary process when evaluating site-specific management actions.

43 CFR 3809

For the complete BLM regulation, search for 3809 at http://www.blm.gov/search or see http://www.blm.gov/nhp/news/regulatory/3730/3809.html.

BMPs will be adjusted as necessary with feedback from monitoring or other sources of information.

Review and update of this Appendix will be accomplished through plan maintenance.

Roads and Landings

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 271. Best management practices for roads and landings

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
	Location	
Locate roads on stable locations without sediment delivery potential to streams (e.g., ridge tops, stable benches or flats, and gentle-to-moderate side-slopes). And avoid headwalls, old slump benches, geologic bedding planes, seeps, and steep channel-adjacent side slopes.	• Coarse Sediment, Fine Sediment, and Organic Debris: Failures from roads built across unstable landforms that may slide into stream channels • Coarse and Fine Sediment: Alters channel form, which warms stream temperatures due to either increased widening or deepening (incising) channels becoming disconnected from the flood plain hyporheic zone	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Temp OAR 340-041-0028 • Turbidity OAR 340-041-0036
Locate new permanent roads outside of Riparian Management Areas, unless construction is under existing reciprocal road right-of-way agreements.	• Coarse and Fine Sediment: Surface erosion or ravel, due to lack of adequate vegetative cover, or nearness to stream channels that may deliver. • Temperature: Roads located adjacent to streams, causing opening in forest canopy that may reduce local stream shade.	• Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Locate temporary road construction outside of Riparian Management Areas. Do not locate temporary roads parallel to stream channels and avoid new stream crossings.	• Coarse and Fine Sediment: Surface erosion or ravel, due to lack of adequate vegetative cover, or nearness to stream channels that may deliver. • Temperature: Roads located adjacent to streams, causing opening in forest canopy that may reduce local stream shade.	• Temp OAR 340-041-0028 • Turbidity OAR 340-041-0036
Locate roads so as to lower cutbank heights and slope angles where ditchlines deliver run-off directly to stream channels.	Coarse and Fine Sediment: Erosion from exposed soils on cut banks	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Locate roads and landings outside of Jurisdictional Wetlands.	Coarse and Fine Sediment: Surface erosion or ravel, due to lack of adequate vegetative cover, or nearness to stream channels that may deliver	• Antidegradation OAR 340-04I-0004 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Locate new landings outside of Riparian Management Areas or at least 200 ft from waterbodies (whichever is greater) and avoid expanding existing landings in Riparian Management Areas when sediment delivery to stream channels could occur.	• Coarse Sediment, Fine Sediment, and Temperature: Surface erosion or ravel, due to lack of adequate vegetative cover or nearness to stream channels that may deliver • Temperature: Increase landing size or shape, causing opening in forest canopy that may reduce local stream shade	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Locate landings in areas with low risk for landslides.	Coarse Sediment, Fine Sediment, and Organic Debris: Failures from landings sited on unstable landforms that may slide into stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Locate excavated material disposal areas outside Riparian Management Areas, floodplains, and unstable areas that could transport sediment to waterbodies.	Coarse and Fine Sediment: Surface erosion or ravel, due to lack of adequate vegetative cover, or nearness to stream channels that may deliver	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
General Construction		
Design roads no wider than needed for the specific use.	Coarse and Fine Sediment: Surface erosion from wet weather, due to lack of adequate vegetative cover that may deliver to a stream channel	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Limit road and landing construction, reconstruction, or renovation activities to the dry season, generally from May into October. When conditions permit operations outside of the dry season, keep erosion control measures concurrent with ground disturbance to the extent that the affected area can be rapidly stormproofed if weather conditions deteriorate.	Coarse and Fine Sediment: Surface erosion from wet weather, due to lack of adequate vegetative cover that may deliver to a stream channel	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
End-haul excavated material to minimize side-casting of waste material if side slopes generally exceed 60 percent, or where side-cast material may enter waterbodies, wetlands, or floodplains.	Coarse Sediment, Fine Sediment, and Organic Debris: Fill run-out or failures from roads built across steep landforms that may slide into stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Conduct pioneer road construction to avoid the deposition of materials in waterbodies, floodplains, or wetlands.	Coarse and Fine Sediment: Pioneer road construction earthwork, with some downslope movement or drifting of unconsolidated soil medium towards waterbodies, floodplains, or wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use controlled blasting techniques.	Coarse and Fine Sediment: Blasting with radial movement of unconsolidated soil medium or rock fragments, towards waterbodies, floodplains, or wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use only soil and rock materials in permanent road fills. Build up fills by layering; compact between 85 and 95 percent maximum density. Provide for additional fill drainage (e.g. use geo-textile fabrics, etc.) in landslide prone areas.	Coarse Sediment, Fine Sediment, and Organic Debris: Failures from roads with inadequate fill construction, or without proper drainage, that may slide into stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use temporary sediment containment structures (e.g. silt fencing).	Coarse and Fine Sediment: New earthwork, lacking vegetative cover, that may erode and deliver to waterbodies, floodplains, or wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Surface roads if they would be subject to traffic during wet weather.	Coarse and Fine Sediment: Road tread erosion, increased by traffic, especially during wet weather on susceptible soil types, causing rilling or rutting, and delivery to a stream channel	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Stabilize bare soil from construction prior to fall rains.	Coarse and Fine Sediment: Vegetative and organic ground cover, decreasing soil detachment, transport and delivery to stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Seed and mulch cut and fill slopes, ditchlines, and waste disposal areas where soil will support seed growth upon construction completion.	Coarse and Fine Sediment: Vegetative and organic ground cover, decreasing soil detachment, transport and delivery to stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Clear channels/ditches above culverts prior to fall rains.	Coarse and Fine Sediment: Culvert inlets becoming plugged with floatable organic debris, resulting in water ponding against the road fill, and headcutting and loss of the fill at the crossing or diversion and/or gullying down the road ditchline and loss of the road fill at another site, with sediment delivery to waterbodies, floodplains, or wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Correct special drainage problems (e.g., high water table, seeps) that effect stability of road subgrade through the use of perforated drains, geotextiles, or drainage bays.	Coarse and Fine Sediment: Saturated fills or wet areas that could fail or erode and deliver sediment to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Conduct slope rounding on tops of cut slopes in clayey soils to reduce sloughing and surface ravel.	Coarse and Fine Sediment: Erosion from exposed soils on cut and fill slopes. Road tread erosion, increased by traffic, especially during wet weather on susceptible soil types, causing rilling or rutting, and delivery to a stream channel.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1)&(13) • Turbidity OAR 340-041-0036
Windrow slash at the base of newly constructed fill slopes to catch sediment.	Coarse and Fine Sediment: Erosion from exposed soils on cut and fill slopes. Road tread erosion, increased by traffic, especially during wet weather on susceptible soil types, causing rilling or rutting, and delivery to a stream channel.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1)&(13) • Turbidity OAR 340-041-0036
Surface Drainage		
Provide effective drainage away from the road surface in maintained ditches on crown and ditch roads.	Coarse and Fine Sediment: Effective road surface drainage to the forest floor, preventing sediment delivery to stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
In-slope low traffic volume roads where the road footprint or underlying soil formation is very rocky, not erodible or subject to failure.	Coarse and Fine Sediment: Effective road surface drainage to the forest floor, preventing sediment delivery to stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Out-slope low traffic volume roads to provide surface drainage on road gradients less than 8 percent, where an inside ditch is not planned.	Coarse and Fine Sediment: Effective road surface drainage to the forest floor, preventing sediment delivery to stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use rolling drainage dips and/or lead-off ditches as options in lieu of culverts for low traffic volume roads with less than 10 percent gradient or where blocking roads is a road management objective.	Coarse and Fine Sediment: Effective road surface drainage to the forest floor, preventing sediment delivery to stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Locate surface water drainage measures (water bars, rolling dips, etc.) where water might accumulate, or where there is an outside berm that prevents drainage from exiting the roadway. Install during the dry season.	Coarse and Fine Sediment: Effective surface drainage to the forest floor, preventing sediment delivery to stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Roll the grade in erodible and unstable soils to reduce surface water volume and velocities.	Coarse and Fine Sediment: Effective surface drainage to the forest floor, preventing sediment delivery to stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Divert road and landing runoff water away from headwalls or unstable areas adjacent to stream channels.	Coarse and Fine Sediment: Water volume concentration resulting in headwall saturation with possible failures to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Shape landings to spread surface water runoff to natural, well-vegetated, stable ground.	Coarse and Fine Sediment: Effective surface drainage to the forest floor, preventing sediment delivery to stream channels	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Prevent diversion of water from streams into road ditches.	Coarse and Fine Sediment: Concentrated water flow from streams causing ditch erosion, and sediment delivery to another stream channel. Dewatering of a stream channel with negative effects on fishes and aquatic life.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1)&(13) • Turbidity OAR 340-041-0036
For roads involving very erodible soils near streams: • Construct 75 feet lead-in ditch to catchbasins • Require rock armoring of lead-in ditch for through fills greater than 6 feet in height • Design catch basins in a manner that would settle out transported sediments. Maintain these basins.	Coarse and Fine Sediment: Concentrated water flow from roads and subsequent soil movement to streams	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1)&(13) • Turbidity OAR 340-041-0036
Cross Drains		
Locate cross drains at intervals sufficient to prevent water volume concentration and accelerated ditch erosion.	Coarse and Fine Sediment: Water volume concentration, resulting greater erosive energy, rilling and gullying road ditchlines and delivery to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Increase cross drain frequency through unstable areas.	Coarse and Fine Sediment: Water volume concentration, resulting in headwall saturation with possible failures to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Use cross drainage culverts that are a minimum of 18 inches in diameter.	Coarse and Fine Sediment: Cross drain restricted size that can plug with sediments and debris, causing water flow volume concentration in ditchlines resulting in gullying with materials delivered to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Construct cross drainage culverts or drainage dips immediately upgrade of stream crossings to prevent ditch sediment from entering the stream.	Coarse and Fine Sediment: Concentrated ditch flow from storm events or snowmelt, causing erosion of the ditchline or carrying sediment sloughed from the cutbank, that if left unchecked may deliver to a stream channel	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Site cross drains to exit on convex slopes and avoid discharge onto erodible and/or unstable ground, (such as headwalls, slumps, or block failure zones), or directly into stream channels. Provide a buffer or sediment basin between the cross drain outlet and waterbodies, floodplains, or wetlands.	Coarse and Fine Sediment: Water volume concentration, resulting in headwall saturation with possible failures to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Armor drainage dips.	Coarse and Fine Sediment: Effective surface drainage to the forest floor, preventing water volume concentration and sediment delivery to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Install downspout structures and/ or energy dissipators (e.g., rock material) at cross drain outlets or drain dips where water is discharged onto loose material or erodible soils, fills, or steep slopes.	Coarse and Fine Sediment: Concentrated ditch flow from storm events or snowmelt, causing erosion of the ditchline or carrying sediment sloughed from the cutbank that if left unchecked, may deliver to a stream channel	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Extend all downspout structures to the toe of fill onto undisturbed ground.	Coarse and Fine Sediment: Convey surface water safely off fills, preventing erosion and sediment delivery to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Cut protruding “cannon” culverts at the fill surface, install downspout and/or energy dissipators on erodible fills.	Coarse and Fine Sediment: Convey surface water safely off fills, preventing erosion and sediment delivery to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Place protective rock at culvert entrance.	Coarse and Fine Sediment: Prevent scour or road fills causing sediment delivery to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use slotted risers, over-sized culverts or build catch basins.	Coarse and Fine Sediment: Culvert plugging causing road fill failure and slug injections of sediments to waterbodies, floodplains and wetlands	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Stream Crossings		
Install all crossings during the low flow period (generally June 15 to September 15).	Coarse and Fine Sediment: Sediment movement downstream during periods of low turbidities with possible effects on aquatic life	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Stream Crossings: Permanent Stream Crossings		
Size culverts, bridges, and other stream crossings for the 100-year flood event (including allowance for bed load and small floatable debris) without exceeding capacity or diversion. Match culvert width with active channel width.	Coarse Sediment, Fine Sediment, nd Organic Debris: Floodwaters exceeding pipe capacity, causing overtopping of pipe and fills, with ensuing headcutting and loss of road fill.	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Limit the number of new stream crossings.	Coarse and Fine Sediment: Sediment entry of road related run-off	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Construct the stream crossing approach at a right angle (or as near a right angle as possible) to the stream.	Coarse and Fine Sediment: Earthwork near waterbodies, floodplains and wetlands causing sediment delivery.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Locate culvert placement on a well defined, unobstructed, and straight reach of stream. Avoid locations that require a stream channel to be straightened beyond the length of a culvert.	Coarse and Fine Sediment: Earthwork near waterbodies, floodplains and wetlands causing sediment delivery.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Do not install culverts on fill material in ephemeral or intermittent channels.	Coarse and Fine Sediment: Floodwater piping or eroding unconsolidated road fill, causing failures with sediment delivery to waterbodies, floodplains and wetlands.	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Divert (e.g., coffer dam, pumping etc.) the stream around the work area. Maintain diversion until all instream work is completed. Pump seepage water that may escape the containment to off-stream filtration area.	Coarse and Fine Sediment: rosion at the instream construction site causing sediment movement downstream during periods of low turbidities with possible effects on aquatic life.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use containment and filtering techniques (e.g., bladder barriers, silt curtains etc.) if diversion is not possible. Place sediment controls along or immediately downstream of the instream work.	Coarse and Fine Sediment: Sediment movement downstream during periods of low turbidities with possible effects on aquatic life.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Limit activities of mechanized equipment to streambank areas or temporary platforms when installing or removing structures.	Coarse and Fine Sediment: Erosion at the instream construction site causing sediment movement downstream	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Countersink culvert below the streambed. Increase culvert diameters accordingly.	Coarse and Fine Sediment: Scour of streambed at culvert outlet, causing entrainment of sediment in flowing water and delivery to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Use stream crossing protection (e.g., hardened crossing, fill armoring, grade dipping, etc.) where high debris loads are expected (such as debris torrent channels) to allow overflow without loss of the fill.	Coarse Sediment, Fine Sediment, and Organic Debris: Debris flows plugging culverts or removing road fills with high delivery of sediments and materials to waterbodies, floodplains and wetlands.	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Provide adequate stream bank protection using bioengineering techniques (e.g., rock and/or organic material) where bank erosion would occur.	Coarse and Fine Sediment: Stream scour of road fill, causing entrainment of sediment in flowing water and delivery to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Provide structural erosion control measures (e.g., rip-rap, wing walls, etc.) on erosion-prone fills, inlets, and outlets.	Coarse and Fine Sediment: Scour of streambed at culvert outlet, causing entrainment of sediment in flowing water and delivery to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Place energy dissipators (e.g., large rock) at the outlet of culverts on streams.	Coarse and Fine Sediment: Stream scour of road fill, causing entrainment of sediment in flowing water and delivery to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Stabilize fill material over stream crossing structures immediately after construction has been completed, normally before October 15. Exposed soils would be seeded and mulched. Temporarily suspend activity if rain saturates soils to the extent that there is potential for movement of sediment from the road to the stream. Soils must be covered or temporarily stabilized during work suspension.	Coarse and Fine Sediment: Surface erosion with sediment delivery to waterbodies, floodplains and wetlands.	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Incorporate additional design criteria (e.g., rock blankets, buttressing, relief pipes higher in the fill, etc.) for deep fills to lesson the susceptibility of fill failures.	Coarse Sediment, Fine Sediment, and Organic Debris: Floodwaters exceeding pipe capacity, causing overtopping of pipe, possible piping through fills with possible collapse or overtopping, with ensuing headcutting, loss of road fill, and possible dam break flood scouring downstream reaches.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use slotted risers, trash racks, or over-sized culverts to prevent culvert plugging in areas of active debris movement.	Coarse Sediment, Fine Sediment, and Debris: Mobile debris and materials plugging culverts with overtopping and failure of the road fill, and possible dam break flood, scouring downstream reaches	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Install permanent stream crossing structures before heavy equipment moves beyond the crossing area. Where this is not feasible, install temporary crossings.	Coarse and Fine Sediment: Sediment movement downstream during periods of low turbidities with possible effects on aquatic life	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Stream Crossings: Temporary Stream Crossings for Roads and Skid Trails		
Design temporary structures to keep vehicles/equipment out of the stream.	Coarse Sediment, Fine Sediment, Oil, and Toxins: Vehicles wheel tracks breaking down banks, to access stream channel bottoms, driving through stream water column, disturbing fish habitat, with possible release of oil, and asbestos from brake linings and similar toxins.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Oil and Floating Solids OAR 340-041-0007 • Statewide Narrative Criteria Toxics OAR 340-041-0007 • Turbidity OAR 340-041-0036
Limit the number of new temporary crossings on a stream.	Coarse and Fine Sediment: Sediment movement downstream during periods of low turbidities with possible effects on aquatic life.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use washed river rock as backfill material or crushed rock over geo-textile fabric, as fill over temporary culverts.	Coarse and Fine Sediment: Higher than anticipated streamflows, washing over or through temporary road crossing.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use methods other than fill first, or use the least amount of fill possible to facilitate the temporary stream crossing structure if a non-fill structure is not possible.	Coarse and Fine Sediment: Higher than anticipated streamflows, washing over or through temporary road crossing.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
No driving of mechanized equipment in the stream channel to the area that is necessary for installation and removal operations. Work from bank or temporary platforms.	Coarse Sediment, Fine Sediment, Oil, and Toxins: Mechanized equipment working within the stream channel, disturbing fish habitat, causing turbidity, and possible release of oil, and similar toxins.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Oil and Floating Solids OAR 340-041-0007 • Statewide Narrative Criteria Toxics OAR 340-041-0007 • Turbidity OAR 340-041-0036
Limit the installation and removal of temporary crossing structures to only one time during the same year and within the prescribed work period where possible. Follow practices under the Closure/Decommissioning section for removing stream crossing drainage structures and reestablishing natural drainage configuration.	Coarse and Fine Sediment: Fall or winter streamflows washing over temporary road and high stream energies washing a portion or all of the crossing downstream.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Stream Crossings: Low-Water Ford Stream Crossings		
Use materials that would withstand 100-year flow events (e.g., concrete, well anchored concrete mats, etc.) on permanent crossings.	Coarse Sediment, Fine Sediment, and Toxins: High streamflow undermining or twisting structure, with possible channel shifts, and partial collapse or loss of structure.	• Statewide Narrative Criteria Toxics OAR 340-041-0007 • Turbidity OAR 340-041-0036
Harden approaches with non-erodible materials on permanent crossings. Provide relief drainage on approaches.	Coarse Sediment, Fine Sediment, and Toxins: Loose road surfacing, washing into the stream during storms.	Turbidity OAR 340-041-0036
Use washed rock/gravel in temporary crossings, where a non-fill structure is not possible.	Coarse and Fine Sediment: Higher than anticipated streamflows, washing over or through temporary road crossing.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Restrict access to temporary crossings.	Coarse Sediment, Fine Sediment, Oil, and Toxins: Vehicles driving through stream water column, disturbing fish habitat, with possible release of oil, and asbestos from brake linings and similar toxins.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Oil and Floating Solids OAR 340-041-0007 • Statewide Narrative Criteria Toxics OAR 340-041-0007 • Turbidity OAR 340-041-0036
Use ramped low water fords in debris flow susceptible streams.	Coarse and Fine Sediment: Debris flows piling against road fills, plugging culverts and overtopping and loss of road prism, or dam break flood wave scouring downstream habitat.	Turbidity OAR 340-041-0036
Road Use and Dust Abatement		
Apply durable rock surfacing to withstand expected loads and traffic volume.	Coarse and Fine Sediment: Road rock breaking down to fines, and washing from roads to ditchlines to stream channels.	Turbidity OAR 340-041-0036
Avoid wet season (generally, November through April) hauling on unsurfaced roads.	Coarse and Fine Sediment: Road surface becoming soft and eroding and washing from roads to ditchlines to stream channels.	Turbidity OAR 340-041-0036
Apply structural treatments (i.e., adjust frequency of cross-drain spacing, sediment barriers or catch basins, gravel lifts or asphalt road surfacing at stream crossing approaches, and clean and armor ditchlines) for winter hauling.	Coarse and Fine Sediment: Road ditchlines gaining water volume concentration, transporting soil material to stream channels, or sediment sources near channels that can flow overland during storms by sheetwash or rill erosion, depositing soil material into stream channels.	Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Suspend timber hauling during wet weather when road surface degradation results in sediment delivery to waterbodies, floodplains and wetlands. Hauling could resume when ditch flow subsides or turbidity standards are met.	Coarse and Fine Sediment: Road erosion with potential transport to the channel and floodplain.	Turbidity OAR 340-041-0036
Suspend timber hauling during wet weather when road run-off delivers sediment at higher concentrations than the existing conditions in the receiving stream. Hauling could resume when ditch flow subsides, or when conditions allow turbidity standards to be met.	Coarse and Fine Sediment: Road erosion with potential transport to the channel and floodplain.	Turbidity OAR 340-041-0036
Remove snow on haul roads in a manner that will protect roads and adjacent resources. Remove or place snow berms to prevent water concentration on the roadway or on erodible side-slopes or soils.	Coarse and Fine Sediment: Road erosion with potential transport to the channel and floodplain.	Turbidity OAR 340-041-0036
Wash equipment at sites with no potential for run-off into waterbodies, floodplains, or wetlands.	Coarse and Fine Sediment: Soil erosion with potential transport to the channel and floodplain.	Turbidity OAR 340-041-0036
Use water or approved surface stabilizers/dust palliatives to reduce surfacing material loss and buildup of fine sediment that may wash off into waterbodies, floodplains, or wetlands.	Coarse and Fine Sediment: Road surfacing becoming detached and blowing or washing from roadways to ditchlines to stream channels.	Turbidity OAR 340-041-0036
Maintenance		
Avoid routine machine cleaning of ditches during the wet season (generally, November through April).	Coarse and Fine Sediment: Removing vegetation or fill material from ditches in the wet season would increase bare soils susceptible to erosion, with potential delivery to stream channels.	Turbidity OAR 340-041-0036
Avoid undercutting of cut-slopes when cleaning ditchlines. Seed and mulch bare soils.	Coarse and Fine Sediment: Removing vegetation or fill material from ditches or undercutting backslopes would increase bare soils susceptible to erosion, with potential delivery to stream channels.	Turbidity OAR 340-041-0036
Promptly remove slide material when it is obstructing road surface and ditchline drainage.	Coarse and Fine Sediment: Slide material, being eroded by ditch streamflow and routing to stream channels, especially during storms.	Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
End-haul sloughed or excavated materials to a stable site outside Riparian management areas with no potential to reach waterbodies, wetlands and floodplains. Avoid wasting loose ditch or surface material over the shoulder where it can cause stream sedimentation or weaken slump prone areas.	Coarse and Fine Sediment: Wasting soil material on steep slopes, may trigger a debris avalanche that could enter a stream channel, delivering sediment and debris.	• Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Turbidity OAR 340-041-0036
Keep road inlet and outlet ditches, catch basins, and culverts free of obstructions, particularly before and during winter precipitation and spring run-off.	Coarse and Fine Sediment: Plugged culverts by sediment and debris, leading to los of road fill and movement of road sediment downstream.	Turbidity OAR 340-041-0036
Repair damaged inlets and downspouts to maintain drainage design capacity.	Coarse and Fine Sediment: Plugged culverts by sediment and debris, leading to los of road fill and movement of road sediment downstream.	Turbidity OAR 340-041-0036
Blade and shape roads to conserve existing aggregate surface material, retain the original crowned or out-sloped self-draining cross section, prevent or remove eroding berms (except those designed for slope protection) and other irregularities that retard normal surface runoff.	Coarse and Fine Sediment: Road erosion with potential transport to the channel and floodplain.	Turbidity OAR 340-041-0036
Eliminate undesirable berms that retard surface runoff.	Coarse and Fine Sediment: Road erosion with potential transport to the channel and floodplain.	Turbidity OAR 340-041-0036
Retain low-growing, herbaceous ground cover and brush on cut-and-fill slopes and ditchlines during the wet season (generally, November through April).	Coarse and Fine Sediment: Increased vegetative cover rapidly diminishes surface erosion potential, and delivery of sediment to stream channels.	Turbidity OAR 340-041-0036
Cut roadside vegetation rather than pulling it out and disturbing the soil.	Coarse and Fine Sediment: Pulling vegetation near ditchlines, creates loose soil material that may fall or wash into ditchlines and then route to stream channels.	Turbidity OAR 340-041-0036
Closure and Decommissioning		
• Decommission new roads not included in the permanent road system upon completion of use, or stormproof if needed the following season. • Decommission older, under used roads that require high maintenance where regular maintenance is unlikely to occur due to lack of resources. • Decommission to Level 1 and any other appropriate level as described below.	Coarse and Fine Sediment: Surface erosion with delivery to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Level 1: Gate or block roads not needed, but not recommended to be fully decommissioned.	Coarse and Fine Sediment: Wheel track formation and rilling/gullying with delivery to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Level 2: Convert existing drainage structures such as ditches and cross drain culverts to a long-term no maintenance drainage configuration such as large dips, outsloped road surface, and well drained, high-capacity waterbars.	Coarse and Fine Sediment: Sediment accumulation or debris plugging cross drains causing road erosion.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Remove stream crossing culverts and in-channel fill material during low flow (generally, June 15 to September 15) and prior to fall rains. Pull back road fill to match channel widths and establish former drainageways when removing culverts.	Coarse and Fine Sediment: Sediment accumulation or debris plugging stream culverts, causing road gully erosion or stream crossing failure. Stream channels readjusting to active channel width, entraining road fill materials.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Place excavated material from removed stream crossings in a stable location where it would not reenter the stream. If necessary, place sediment and erosion controls around all stockpiled material.	Coarse and Fine Sediment: Surface erosion delivering to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Reestablish stream crossings to the natural stream gradient. Reestablish stream side slopes to the natural contour.	Coarse and Fine Sediment: Stream bed nickpoints traveling upstream, scouring below the armor layer in gravel bed streams causing excessive channel erosion. Surface erosion delivering to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Seed (with native or approved seed), mulch, and plant (with native tree species) streambanks and side slopes as soon as possible after culvert removal has been completed, and before October 15.	Coarse and Fine Sediment: Surface erosion delivering to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Place sediment trapping materials (such as straw bales) at the toe of the stream adjacent side slopes.	Coarse and Fine Sediment: Surface erosion delivering to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Waterbar decommissioned roads on each side of stream crossings.	Coarse and Fine Sediment: Surface erosion delivering to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Level 3: Seed and mulch the road surface, where erosion could occur.	Coarse and Fine Sediment: Surface erosion delivering to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Level 4: Till the roadbed, landings, and construction areas.	Coarse and Fine Sediment: Water concentration eroding compacted surfaces resulting to sediment delivery to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Level 5: Pull back road fill and recontour to the natural slopes.	Coarse and Fine Sediment: Water concentration eroding compacted surfaces resulting to sediment delivery to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Suspend decommissioning work if rain saturates soils to the extent that there is potential for environmental damage, including movement of sediment from the road to the stream.	Coarse and Fine Sediment: Surface erosion delivering to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Stormproof open roads not scheduled for planned maintenance.	Coarse and Fine Sediment: Surface erosion with delivery to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Place woody material or other appropriate barriers to discourage off-highway vehicle use on decommissioned roads, unless specifically designated for this use.	Coarse and Fine Sediment: Surface erosion delivering to waterbodies, floodplains and wetlands.	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Water Source Development and Use		
Construct water sources during low flows (generally, August through October).	Coarse Sediment, Fine Sediment, and Aquatic Habitat: Changing or removing stream habitat and associated stream turbidity.	• Biocriteria OAR 340-041-0011 • Turbidity OAR 340-041-0036
Locate road approaches to in-stream water source developments so as to limit disturbance to vegetation. Surface these approaches with rock.	Coarse Sediment, Fine Sediment, and Toxins: Road surfacing, washing into the stream during storms.	Turbidity OAR 340-041-0036
Avoid use of road fills for water impoundment dams unless specifically designed for that purpose. Existing road fill impoundments are required to pass 100-year flood events without failure.	Coarse Sediment, Fine Sediment, and Toxins: Road fill washout, leading to stream sedimentation	• Biocriteria OAR 340-041-0011 • Statewide Narrative Criteria Road Building Waste Materials OAR 340-041-0007 • Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Direct overflow from off-channel water developments back into the stream as long as overflow water characteristics remain the same.	Low Flows: Decreasing low flows, potentially causing increased stream water temperatures, and decreased stream oxygen levels.	• Dissolved Oxygen OAR 340-041-0016 • Temperature OAR 340-041-0028

Best Management Practices for Roads and Landings	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Do not construct temporary pump chances. When necessary, use temporary plastic dams to create chances and remove these dams when not actively pumping.	Low Flows: Decreasing low flows, potentially causing increased stream water temperatures, and decreased stream oxygen levels.	• Dissolved Oxygen OAR 340-041-0016 • Temperature OAR 340-041-0028
Suspend pump intakes near the deepest/highest quantity of flow of the stream. Do not place pump intakes on the substrate or edges of the stream channel.	Coarse Sediment, Fine Sediment, and Stream Habitat: Changing or removing stream habitat and associated stream turbidity.	• Biocriteria OAR 340-041-0011 • Turbidity OAR 340-041-0036

Timber Harvest Activities

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 272. Best management practices for timber harvest activities

Best Management Practices for Timber Harvest Activities	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
	Cable Yarding	
Yard away from riparian management areas	• Coarse and Fine Sediment: Yarding operations can cause compaction, displacement and exposure of soils and sediment sources in zones with potential for transport and delivery of sediment to water bodies and wetlands resulting in turbidity. • Water Temperature: Yarding operations in RMA's can result in vegetation canopy loss due to removal for safety and operations. Decreases in canopy can result in losses of effective shade and exposure of stream channel to solar radiation, resulting in heating of the waterbody.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Remove introduced slash into waterbodies within before the next precipitation and runoff event.	Coarse and Fine Sediment: Debris jams can form damming the stream and directing streamflow against banks, leading to bank erosion , or a dam break flood.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036

Best Management Practices for Timber Harvest Activities	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Design yarding corridors so as to limit canopy loss in riparian management areas and to meet shade targets. Techniques include limiting the number of such corridors, using narrow widths, and using a perpendicular orientation to the stream.	Water Temperature: Yarding corridors in RMA's can result in vegetation canopy loss due to removal for safety and yarding operations. Decreases in canopy can result in losses of effective shade and exposure of stream channel to solar radiation, resulting in heating of the waterbody. Removal of more than 80% effective shade can exceed criteria and TMDL Targets	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Temperature OAR 340-041-0028
Require full suspension over flowing streams, non-flowing streams with erodible bed and bank, and jurisdictional wetlands.	Coarse and Fine Sediment: Log yarding through waterbodies can cause direct introduction of sediment into water or channels resulting in accumulation of sediment and turbidity. Displacement of stream and wetland bed and banks exposing soil to erosion resulting in sedimentation and turbidity.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036
Limit downhill logging into riparian management areas or where yarding trails can expand the stream or ditch network.	Coarse and Fine Sediment: Downhill logging into RMA's could result in converging skid paths intersecting stream channels, and less than full suspension, which could result in sediment accumulation, delivery and turbidity	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036
Widely space yarding corridors or new road crossings within riparian management areas if no practical alternative exists to treat adjacent uplands, or to avoid building more roads or landings.	Temperature and Sediment: Site specific acceptance of RMA entry can reduce overall displacement of soils and canopy losses in riparian areas, floodplains and wetlands. Cumulative increases in sediment and temperature can be reduced through tradeoffs with local site specific impacts.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Where slopes exceed 60 percent along stream channels, yard with full suspension, one-end suspension using seasonal restrictions, or one-end suspension using a standing skyline with lateral yarding capacity. Yard remaining areas using one-end suspension	Coarse and Fine Sediment: Slopes greater than 65% present a high risk of soil displacement and transport downslope to RMAs due to gravitational forces. Increased displacement from lack of log suspension can cause excessive displacement, exposure of sediment sources and delivery to waterbodies and wetlands.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036
Implement erosion control measures such as water-barring, slash placement and seeding in cable yarding corridors where the potential for erosion and delivery to waterbodies, floodplains and wetlands exists.	Coarse and Fine Sediment: Exposure of soils to erosive forces of water with potential delivery to waterbodies and wetlands.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036

Best Management Practices for Timber Harvest Activities	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
	Ground-Based Yarding	
Exclude ground-based yarding on hydric soils.	Coarse and Fine Sediment: Displacement and exposure of soils through equipment operation with potential delivery of sediment to waterbodies resulting in sedimentation and turbidity	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036
When operating within riparian management areas: • Avoid construction of new skid trails by preferentially using existing skid trails. • In previously un-entered stands, use designated skid trails to limit soil compaction to no more than 12 percent of the harvest area. • Site-specific conditions, such as shade retention or soil erodibility, may require a ground-based equipment exclusion zone (50 to 75 feet) adjacent to waterbodies, floodplains, and wetlands to provide filtration and shade retention. • Limit width and attain one end suspension. • Restrict ground-based harvest and skidding operations to periods of low soil moisture when soils have the most resistance to compaction and displacement. • Use “one-pass” harvest techniques.	• Coarse and Fine Sediment: Displacement and exposure of soils through equipment operation with potential delivery of sediment to waterbodies resulting in sedimentation and turbidity • Temperature: Loss of vegetation canopy due to removal during yarding operations. Decreased shade and exposure of stream channel to solar radiation and increased heating.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Temperature OAR 340-041-002 • Turbidity OAR 340-041-0036
Limit mechanical track equipment to slopes less than 35 percent and nontrack mechanized equipment to slopes less than 20 percent.	Coarse and Fine Sediment: Displacement and exposure of soils through equipment operation with potential delivery of sediment to waterbodies resulting in sedimentation and turbidity	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036

Best Management Practices for Timber Harvest Activities	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Designate skid trails where water from trail surface would not be channeled into unstable areas adjacent to waterbodies, floodplains, and wetlands.	Coarse and Fine Sediment: Compaction of skid trails resulting in additional surface flow to unstable areas. Increases in water to unstable areas can elevate pore pressure and weight of unstable area causing mass wasting and delivery of sediment and turbidity to waterbodies and wetlands.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036
Directionally fall trees towards skid trails.	Coarse and Fine Sediment: Minimize compaction of skid trails resulting in loss of infiltration, surface water flow and erosion of exposed soils. Potential delivery to waterbodies and wetlands resulting in sedimentation and turbidity.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036
Apply erosion control practices to all disturbed areas (eg., skid trails) with potential for erosion and delivery to waterbodies, floodplains, or wetlands. These practices could include tillage, water barring, seeding, mulching, and woody debris placement.”	Coarse and Fine Sediment: Exposure of soils to erosive forces of water with potential delivery to waterbodies and wetlands.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036
Allow logging on snow when snow depth is greater than 18 inches or over frozen ground.	Coarse and Fine Sediment: Displacement, compaction, and exposure of soils through equipment operation with potential delivery of sediment to waterbodies resulting in sedimentation and turbidity.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1)&(13) • Turbidity OAR 340-041-0036
Block skid roads that intersect haul roads at the end of seasonal use.	Coarse and Fine Sediment: Displacement, compaction, and exposure of soils through equipment operation with potential delivery of sediment to waterbodies resulting in sedimentation and turbidity.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1)&(13) • Turbidity OAR 340-041-0036

Best Management Practices for Timber Harvest Activities	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
	Helicopter	
Use helicopter yarding in waterbodies, floodplains, and wetlands when other BMP's will not meet water quality standards/ criteria.	• Coarse and Fine Sediment: Soil exposure due to yarding operations resulting in soil erosion with potential transport to the waterbody resulting in sedimentation and turbidity. • Temperature: Loss of vegetation canopy due to removal during yarding operations. Decreased shade and exposure of stream channel to solar radiation and increased heating.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
	Horse	
Limit horse logging in riparian management area's to slopes less than 20 percent.	Coarse and Fine Sediment: Soil on skid trails exposed to water erosion with potential delivery to waterbodies , floodplains, and wetlands resulting in sedimentation and turbidity.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036
Construct waterbars on horse skid trails when there is potential for soil erosion and delivery to waterbodies, floodplains, and wetlands.	Coarse and Fine Sediment: Soil on skid trails exposed to water erosion with potential delivery to waterbodies , floodplains, and wetlands resulting in sedimentation and turbidity.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Turbidity OAR 340-041-0036

Silvicultural Activities

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 273. Best management practices for silvicultural activities

Best Management Practices for Silvicultural Activities	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
General		
During active silvicultural management of riparian management areas, retain dominant site potential species within primary shade zones.	Temperature: Persistent stream canopy provides consistent effective shade over time and will contribute to meeting shade targets and temperature criteria.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Temperature OAR 340-041-0028
Limit crossing stream channels with motorized support vehicles (e.g., ATV's) and mechanized equipment to existing road crossings.	Coarse and Fine Sediment: Vehicle and equipment crossing streams can cause breakdown of bed and banks exposing soil to water erosion and resulting turbidity.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Thinning		
Fell thinned trees away from steams when possible.	Coarse and Fine Sediment: Accumulation of slash in channels can redirect flows out of the stream channel, increasing stress on banks and resulting in streambank and floodplain erosion and increases in local turbidity	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Use manual techniques (includes chainsaws) for thinning within riparian management areas.	Coarse and Fine Sediment: Avoiding soil exposure from the use of ground based equipment, and the possible erosion and delivery of sediment to waterbodies and wetlands resulting in turbidity increases.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Retain as much down, woody material in riparian management areas as possible.	Coarse and Fine Sediment: RMA's function as filtration barriers to fine sediment if the soil surface and organic material is retained on the soil surface.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Remove excess slash from steep headwalls (e.g., gross yard). Embedded logs or other logs that contribute to channel or slope stability will not be removed.	Coarse and Fine Sediment: Accumulation of slash in unstable areas associated with channels can over weight slope surface causing translational sliding and debris torrents , delivering sediment and resulting in downstream turbidity.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036

Best Management Practices for Silvicultural Activities	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Scatter treatment debris on disturbed soils and water bar any yarding trails that could erode and deposit in water bodies , floodplains, and wetlands	Coarse and Fine Sediment: Erosion of exposed soil and delivery to waterbodies and wetlands resulting in turbidity increases.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Fertilization		
Avoid applying fertilizer to riparian management areas, floodplains, and wetlands.	Nutrient Enrichment: Application of Nitrate to potentially nitrogen rich riparian areas, leading to leaching and delivery of nitrates through local groundwater to and water bodies.	• 0.5 mg/L toxic to rainbow trout • Biocriteria OAR 340-041-0011
Locate storage, transfer, and loading sites outside riparian management areas and away from streams and road ditches that are linked to stream channels.	Nutrient Enrichment: Spilling of fertilizer with potential delivery of nutrients to waterbodies and wetlands through leaching or direct surface water transport.	• 0.5 mg/L toxic to rainbow trout • Biocriteria OAR 340-041-0011
Apply fertilizer when climate conditions (wind and rain) minimize risk of application to water bodies, floodplains, and wetlands.	Nutrient Enrichment: Application of Nitrate to potentially nitrogen rich riparian areas, leading to leaching and delivery of nitrates through local groundwater to and water bodies.	• 0.5 mg/L toxic to rainbow trout • Biocriteria OAR 340-041-0011
Stand Conversion		
Klamath Falls: • Use mechanical treatments in aspen stands during the dry season (generally, May through September). • Where slopes along streams are less than 30%, limit mechanical equipment to 25 feet from the edge of the riparian zone. • Where slopes along streams are greater than 30%, limit mechanical equipment to 50 feet from the edge of the riparian zone. • Limit mechanical entry to within 50 feet from the edge of wetlands riparian indicators.	Coarse and Fine Sediment: Displacement and exposure of soils through equipment operation with potential delivery of sediment to waterbodies resulting in sedimentation and turbidity.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036

Fire and Fuels Management

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 274. Best management practices for fire and fuels management

Best Management Practices for Fire and Fuels Management	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Fuels Management		
Fuels Management: Underburn, Concentration Burn, and Broadcast Burn		
• Allow low intensity underburns to back into riparian management areas; however no ignition would occur within riparian management areas, unless prescribed for restoration purposes. • Keep concentration and broadcast burns at least 100 feet away from riparian management areas, unless prescribed for restoration purposes. • Locate ignition lines above large open meadows associated with stream channels.	Coarse Sediment, Fine Sediment, and Temperature: • Bare soil in RMA is subject to surface erosion and potential sediment delivery to adjacent waterbody. • Loss of riparian vegetation due to wildfire could reduce shade and increase water temperature.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Avoid ignition of large woody material that is touching the high water mark of a waterbody or that may be affected by high flows.	Coarse and Fine Sediment: Large wood provides channel stabilization and energy dissipation, thus reducing channel erosion and subsequent sedimentation.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
• Avoid delivery of foam or additives to waterbodies, floodplains, or wetlands. • Store and dispose of ignition devices/materials (e.g., flares, plastic spheres, etc.) outside riparian management areas or a minimum of 100 feet from waterbodies, floodplains, and wetlands. • Maintain and refuel equipment (e.g., drip torches, chainsaws, and portable pumps) a minimum of 100 feet from waterbodies, floodplains, and wetlands.	Chemicals: Direct contamination of waterbodies.	Toxic Substances OAR 340-041-0033

Best Management Practices for Fire and Fuels Management	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
• Limit hand constructed firelines inside riparian management areas and prohibit machine constructed firelines in riparian management areas. • Construct firelines by hand on all slopes greater than 35 percent. • Use erosion control techniques such as tilling, waterbaring, or debris placement on firelines. Construct waterbars on tractor and hand firelines. • Avoid placement of any fireline where water would be directed into waterbodies, floodplains, wetlands, headwalls, or areas of instability.	Coarse and Fine Sediment: Firelines can channel water and sediment into waterbodies.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Fuels Management: Pile and Burn		
• Prohibit mechanical piling within riparian management areas. • Prohibit tractor piling in areas that could deliver sediment to waterbodies, floodplains, wetlands.	Coarse and Fine Sediment: Ground disturbance reduces infiltration and increases surface runoff with subsequent soil movement. Erosion more likely on steeper slopes.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Use temporary stream crossings if necessary for equipment to access the opposite side. Follow Temporary Stream Crossing practices under Roads section.	Coarse and Fine Sediment: Equipment can damage streambeds and banks causing turbidity and sedimentation.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Locate hand piles outside riparian management areas for fish-bearing or perennial streams, and springs/ seeps/wetlands, unless prescribed for restoration purposes.	Coarse Sediment, Fine Sediment, and Temperature: • Bare soil is subject to surface erosion. • Loss of riparian vegetation due to fire could reduce shade and increase water temperature.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036

Best Management Practices for Fire and Fuels Management	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Locate hand piles outside of riparian management areas for intermittent streams or above the first slope break, whichever is greater, unless prescribed for restoration purposes.	Bare soil is subject to surface erosion.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Fuels Management: Mechanical and Manual Fuel Treatments		
• No mechanical fuel reduction equipment within 75 feet of streams and other waterbodies, unless prescribed to meet specific land management objectives. • Limit mechanical fuel reduction equipment to slopes less than 35 percent. Restrict non-track mechanized equipment to slopes less than 20 percent.	Ground-based equipment reduces infiltration and increases surface runoff with subsequent soil movement.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Use temporary stream crossings if necessary to access the opposite side with any equipment or vehicles (including ATVs). Follow Temporary Stream Crossing practices under Roads section.	Coarse and Fine Sediment: Stream crossings subject to streambank damage and erosion.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Place residual slash on disturbed areas and seed upon completion when appropriate.	Coarse and Fine Sediment: Bare soil areas are subject to erosion and subsequent sediment delivery to waterbody.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Maintain and refuel equipment (e.g., drip torches, chainsaws, and portable pumps) at least 100 feet from waterbodies, floodplains, and wetlands.	Petroleum Products: Direct contamination of waterbodies.	Toxic Substances OAR 340-041-0033
Wildfire		
Wildfire: Suppression		

Best Management Practices for Fire and Fuels Management	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
• Limit hand constructed firelines and prohibit machine constructed firelines inside riparian management areas. • Where hand constructed firelines are necessary in riparian management areas, angle the approach rather than have it perpendicular to the riparian management area. • Exclude ground-based equipment within riparian management areas. Limit use of heavy equipment adjacent to riparian management areas and on slopes greater than 35 percent.	Coarse and Fine Sediment: Ground-based equipment reduces infiltration and increases surface runoff with subsequent soil movement. Soil disturbance causes soil erosion and potential for soil movement to waterbody.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
• Prevent cutting of logs or woody material if any portion of that material extends into the stream channel. • Fall snags in the riparian management area towards the stream channel when felling is necessary for safety or fire suppression activities.	Coarse and Fine Sediment: Large wood stabilizes channels and prevents channel erosion.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Do not locate incident bases, camps (including spike/remote camps), helibases, staging areas, constructed helispots, and other centers for incident activities in riparian management areas or within 200 feet of any waterbody, floodplain, or wetland.	Coarse Sediment, Fine Sediment, Temperature, and Petroleum Products: Riparian disturbance from equipment and people could increase sediment. Removal of riparian vegetation could cause water temperature increases. Accidental spillage of fuel and other chemicals could enter waterways.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) • Temperature OAR 340-041-0028 • Toxic Substances OAR 340-041-0033 • Turbidity OAR 340-041-0036
Locate and maintain portable sanitation facilities at incident bases, camps (including spike/remote camps), helibases, staging areas, constructed helispots, and other centers for incident activities in accordance with state and local regulations.	Bacteria: Contamination from human waste.	Bacteria OAR 340-041-0009
• Keep chemical retardant, foam, or additives out of waterbodies, floodplains, or wetlands. • Do not use chemical retardants within the riparian management area. • Apply aerial retardant adjacent to riparian management areas by making parallel passes.	Chemical Retardants: Contamination of waterbodies from chemical retardant.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) • Toxic Substances OAR 340-041-0033

Best Management Practices for Fire and Fuels Management	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Wildfire: Rehabilitation		
Implement emergency fire rehabilitation treatments to accomplish erosion control as quickly as possible and before the wet season. Examples include: • Use native or other ecologically appropriate vegetation for short-term cover development and long-term recovery. • Mulch with straw or other suitable material. • Use straw wattles. • Install log erosion barriers. • Spread slash on bare soils. • Place channel stabilization structures. • Place sediment retention structures in channel. • Place trash racks above road drainage structures. • Install drainage structures, such as water bars or drainage dips, on firelines, fire roads, and other cleared areas according to guidelines in *Table 5* (Waterbar spacing by gradient and erosion class). • Repair damaged road drainage facilities. • Block or decommission roads and trails.	Coarse and Fine Sediment: Bare soil areas are subject to erosion and subsequent sediment delivery to waterbody.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036

Best Management Practices for Fire and Fuels Management	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Wildfire: Fuel/Retardant Transport		
If more than 42 gallons of fuel or combined quantity of petroleum product and chemical substances would be transported to a project site, the following precautions would be implemented. 1. Plan a safe route and transfer sites that could contain the transported volume. 2. Plan an active dispatch system that can relay the information to appropriate resources. 3. Ensure a spill containment kit that can adsorb and contain 55 gallons of petroleum product and chemical substances is readily available. 4. Provide for immediate notification in the event of a spill. Have a radio equipped vehicle lead the chemical or fuel truck to the project site. 5. Assemble a spill notification list that includes the district hazardous materials coordinator, DEQ, and spill clean-up contractors. 6. Construct a water user contact list with address and phone numbers. 7. When operating within Source Water Watersheds, pre-estimate travel times through the watershed to predict downstream arrival times. 8. Be prepared to sample water and carry sample containers.	Petroleum and Chemical Substances: Spillage into waterbodies with chemical contamination of waterbodies.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Toxic Substances OAR 340-041-0033

Table 275. Waterbar spacing by gradient and erosion class

Gradient (%)	Waterbar Spacing (feet)[1] Per Erosion Class[2]		
	High Class	Moderate Class	Low Class
2 to 5%	200 ft.	300 ft.	400 ft.
6 to 10%	150 ft.	200 ft.	300 ft.
11 to 15%	100 ft.	150 ft.	200 ft.
16 to 20%	75 ft.	100 ft.	150 ft.
21 to 35%	50 ft.	75 ft.	100 ft.
36+%	50 ft.	50 ft.	50 ft.

[1]Spacing is determined by slope distance and is the maximum allowed for the grade.

[2]The erosion classes include the following rock types:

- High: granite, sandstone, andesite porphyry, glacial or alluvial deposits, soft matrix conglomerate, volcanic ash, and pyroclastics
- Moderate: basalt, andesite, quartzite, hard matrix conglomerate, and rhyolite
- Low: metasediments, metavolcanics, and hard shale

Surface Source Water for Drinking Water

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 276. Best management practices for surface source water for drinking water

Best Management Practices for Surface Source Water for Drinking Water	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Sanitary facilities would be planned, located, designed, constructed, operated, inspected, and maintained to minimize possibilities of water contamination.	Bacteria: Fecal Coliform enrichment of local groundwater and surface water with delivery to downstream drinking water diversion.	• Antidegradation OAR 340-041-0004(1) • Bacteria OAR 340-041-0009 • Statewide Narrative OAR 340-041-0007(1) and (13)
Locate contractor camps outside Oregon Department of Environmental Quality sensitive zones in surface source water watersheds. If this is not possible, require self-contained sanitary facilities.	Bacteria: Fecal Coliform enrichment of local groundwater and surface water with delivery to downstream drinking water diversion.	• Antidegradation OAR 340-041-0004(1) • Bacteria OAR 340-041-0009 • Statewide Narrative OAR 340-041-0007(1) and (13)
Require self-contained sanitary facilities in surface source water watersheds, when long-term camping (greater than 14 days) is involved with contract implementation.	Bacteria: Fecal Coliform enrichment of local groundwater and surface water with delivery to downstream drinking water diversion.	• Antidegradation OAR 340-041-0004(1) • Bacteria OAR 340-041-0009 • Statewide Narrative OAR 340-041-0007(1) and (13)
Provide self-contained sanitary facilities when there is high recreational use (almost continuous occupancy) within Oregon Department of Environmental Quality sensitive zones or along streams above domestic water diversions of record.	Bacteria: Fecal Coliform enrichment of local groundwater and surface water with delivery to downstream drinking water diversion.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Bacteria OAR 340-041-0009
Locate pack, riding, restoration, and logging stock facilities 200 feet away from watercourses upstream of source drinking diversions.	Bacteria: Fecal Coliform enrichment of local groundwater and surface water with delivery to downstream drinking water diversion.	• Antidegradation OAR 340-041-0004(1) • Bacteria OAR 340-041-0009 • Statewide Narrative OAR 340-041-0007(1) and (13)

Best Management Practices for Surface Source Water for Drinking Water	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Do not allow surface occupancy within 200 feet of a recorded domestic or public drinking water diversion.	Bacteria: Fecal Coliform enrichment of local groundwater and surface water with delivery to downstream drinking water diversion.	• Antidegradation OAR 340-041-0004(1) • Bacteria OAR 340-041-0009 • Statewide Narrative OAR 340-041-0007(1) and (13) • Toxic Substances OAR 340-041-0033
Do not apply sewage sludge as a soil amendment in surface source water watersheds, above Domestic Water diversions of record, or within riparian management areas.	Toxic Pollutants: Leaching and surface water movement can transport toxics and bacteria downstream to water supply diversions. Some domestic supplies have no ability to detect or treat this pollution.	• Antidegradation OAR 340-041-0004(1) • Bacteria OAR 340-041-0009 • Statewide Narrative OAR 340-041-0007(1) and (13) • Toxic Substances OAR 340-041-0033
Do not load, transfer, or store chemical, fuel, or fertilizer in sensitive zones in surface source water watersheds.	Toxic Pollutants, Oil, Gas, and Nutrients: Leaks, spills, and improper handling of pesticides, herbicides and petroleum products can leach or be transported by surface water to drinking water diversion points.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and(13) • Toxic Substances OAR 340-041-0033
Conduct equipment maintenance outside site-specific sensitive zones in surface source water watersheds.	Toxic Pollutants, Oil, and Gas: Leaks, spills, and improper handling petroleum products can leach or be transported by surface water to drinking water diversion points.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Toxic Substances OAR 340-041-0033
Use non-oil-based dust suppressants in surface source water watersheds.	Toxic Pollutants, Oil, and Gas: Leaks, spills, and improper application of oil based dust control products can introduce petroleum products to surface water and to drinking water diversion points.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Toxic Substances OAR 340-041-0033
Do not allow mineral lease surface occupancy within sensitive zones in surface source water watersheds.	Toxic Pollutants, Oil, and Gas: Leachate from mineral operations or equipment use may contain chemicals and wastes which is transported and delivered to drinking water diversion points.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Toxic Substances OAR 340-041-0033

Best Management Practices for Surface Source Water for Drinking Water	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Use fire retardant and surfactants as a last resort in fire suppression activities in surface source water watersheds.	Toxic Pollutants: Direct application of fire retardant and surfactants to waterbodies above drinking water intakes can cause delivery of Nitrate reaching concentrations as high as 33 mg/L, well above the primary water quality standard of 1 mg/L. The main chemical of concern in streams 24 hours after a retardant drop is un-ionized ammonia (NH3) is the principal toxic component to aquatic species.	• Antidegradation OAR 340-041-0004(1) • Statewide Narrative OAR 340-041-0007(1) and (13) • Toxic Substances OAR 340-041-0033

Recreation

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 277. Best management practices for recreation

Best Management Practices for Recreation	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
All Recreation Facilities		
Implement erosion control measures on all recreation sites to stabilize exposed soils.	Coarse and Fine Sediment: Minimize sediment delivery to wetlands, floodplains, and waterbodies.	Turbidity OAR 340-041-0036
Locate new recreational facilities, developed and dispersed sites, outside of the water influence area or 100 feet from wetlands, floodplains, or waterbodies, whichever is greater. Low impact uses, such as hiking trails, picnic sites, or water dependant facilities (e.g., boat ramps or docks), are excluded.	Coarse and Fine Sediment: Minimize sediment delivery resulting from surface erosion.	• Bacteria OAR 340-041-0009 • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Developed Recreation Sites		
Sealed vault toilets will be used at all developed recreational facilities, unless a sewage system and drainfield is approved by the Department of Environmental Quality.	Bacteria: Bacterial pollution from improperly constructed sanitation facilities could be injurious to the health of humans and aquatic organisms.	Bacteria OAR 340-041-0009
Construct and maintain refuse disposal sites to avoid water contamination.	Bacteria: Bacteria could enter surface and groundwater if garbage is not disposed of properly.	Bacteria OAR 340-041-0009

Best Management Practices for Recreation	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
When conducting recreation site maintenance, do not cut logs or coarse woody debris if any portion of that material extends in the active stream channel.	Coarse and Fine Sediment: Sediment storage, streambank stability, and reduction of turbidity.	• Antidegradation OAR 340-041-004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Water Dependent Facilities		
Construct boat ramps and approaches with hardened surfaces.	Coarse and Fine Sediment: Impacts to streambanks, turbidity	Turbidity OAR 340-041-0036
Off-Highway Vehicle (OHV) Trails		
Avoid construction of trails within RMAs.	Coarse and Fine Sediment: Surface erosion from trail tread to streams, floodplains, or wetlands.	Turbidity OAR 340-041-0036
Use existing hardened stream crossings to the extent possible when constructing trails through RMAs.	Coarse and Fine Sediment: Old roads converted to trails with rock surfacing at stream crossings reduce sedimentation for OHV trails.	Turbidity OAR 340-041-0036
When constructing or maintaining trails within Riparian Management Areas, do not cut logs or coarse woody debris if any portion of that material extends into the active stream channel.	Coarse and Fine Sediment: Sediment storage, streambank stability, and reduction of turbidity.	• Antidegradation OAR 340-041-004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Prohibit vehicle and off-highway vehicle use in streams, ponds, wetlands, and other waters.	Coarse Sediment, Fine Sediment, and Toxic Pollutants: Direct delivery of sediment and/or petroleum based fluids from vehicles is unnecessary degradation of waters of the State.	• Toxic substances OAR 430-041-0033 • Turbidity OAR 340-041-0036
Stream crossings would be designed to accommodate active channel width, bed load, and fish passage without exceeding capacity or diversion for the 100-year flood event.	Coarse and Fine Sediment: Floodwaters exceeding crossing capacity, causing overtopping of fills, with ensuing headcutting and loss of trail fill.	• Statewide Narrative Criteria Sediment, Adverse Deposits OAR 340-041-0007 • Turbidity OAR 340-041-0036
Construct or maintain trails prior to the wet season.	Coarse and Fine Sediment: Sediment from trail related run-off.	Turbidity OAR 340-041-0036
Locate staging areas outside riparian management areas. Design or upgrade staging areas to prevent sediment/pollutant delivery to wetlands, floodplains, and waterbodies (e.g., rocking or hardening)	Coarse Sediment, Fine Sediment, and Toxic Pollutants: Stop sediment or petroleum products or from reaching streams.	• Toxic substances OAR 430-041-0033 • Turbidity OAR 340-041-0036

Best Management Practices for Recreation	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Harden trail approaches to stream crossings using materials such as geotextile fabric and crushed rock aggregate.	Coarse and Fine Sediment: Sediment from trail related run-off.	Turbidity OAR 340-041-0036
Drain dips will be installed on approaches to stream crossings and reinforced with rock for longevity. Drain dips would be placed within 100 feet of a stream. Large wood would be placed on both sides of the tread to keep riders on the trail and to contain any sediment movement.	Coarse and Fine Sediment: Sediment from trail related run-off.	Turbidity OAR 340-041-0036
Do not use pressure treated wood in construction of bridges over streams where materials are in contact with the stream or may leach into the soil or water.	Toxic Pollutants: Leaching of chemicals from treated wood into adjacent streams.	Toxic substances OAR 430-041-0033
During construction, perennial stream crossings may require a temporary flow diversion structure through the work area. (See Roads Section for Stream Crossing BMPs)	Coarse and Fine Sediment: Exposed soils may be vulnerable to erosion and sediment deposition into streams.	Turbidity OAR 340-041-0036
Prevent vehicle access to nearby wetlands by using suitable barriers.	Coarse and Fine Sediment: Defining trail route may prevent development of new trails into fragile areas susceptible to compaction and sediment transport to water resources.	Turbidity OAR 340-041-0036
Where trails intersect road ditches, provide hardened crossings. Divert water from the trail to keep from reaching wetlands, floodplains, and waterbodies.	Coarse and Fine Sediment - Exposed soils may be vulnerable to erosion, resulting in deposition to road ditches that could flow into nearby streams.	Turbidity OAR 340-041-0036
If trail width is deemed excessive for designated use (such as old roads converted to trails) one side of the trail will be tilled, covered with brush, and seeded or planted.	Coarse and Fine Sediment: Wider trails more prone to erosion and sediment delivery to waterbodies.	Turbidity OAR 340-041-0036
Repair rills and gullies using appropriately sized equipment or by hand.	Coarse and Fine Sediment: Unless tread erosion is maintained regularly, erosion escalates and can route sediment to waterbodies nearby.	Turbidity OAR 340-041-0036
Waterbars, drain dips, and lead off ditches will be constructed or repaired as needed. These features may need rock reinforcement to promote longevity. Drain dips or lead-off features are the preferred design.	Coarse and Fine Sediment: Drainage features can route run-off to stable vegetated land and avoid impacts on water quality.	Turbidity OAR 340-041-0036
Drain dips or lead off ditches will be constructed on steeper gradient trails and approaches to stream crossings.	Coarse and Fine Sediment: Drainage features protect steep trails from chronic erosion as well as leading off surface water before it could reach waterbodies.	Turbidity OAR 340-041-0036

Best Management Practices for Recreation	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Trails (Hiking)		
When constructing or maintaining trails within riparian management areas, do not cut logs or coarse woody debris if any portion of that material extends into the active stream channel. Use alternative passage options, such as earthen ramps, small notch steps, or slight trail realignments, to facilitate maintenance of intact logs.	Coarse and Fine Sediment: Sediment storage, streambank stability, and reduction of turbidity.	• Antidegradation OAR 340-041-004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Turbidity OAR 340-041-0036
Trail Closure		
Remove existing stream crossings or bridges. (See Road Decom. BMPs)	Coarse and Fine Sediment: Unmaintained crossings can fail and deliver sediment to streams.	Turbidity OAR 340-041-0036
Position fill or waste material in a location that would avoid direct or indirect sediment discharges to streams or wetlands.	Coarse and Fine Sediment: Until vegetation is established, or erosion control measures are undertaken, waste material is vulnerable to erosion.	Turbidity OAR 340-041-0036
Restored stream banks would be planted with native vegetation, straw mulched, and planted with water tolerant species where appropriate.	Coarse and Fine Sediment: Exposed soils are vulnerable to erosion in storm events and/or periods of high stream flows.	Turbidity OAR 340-041-0036
Barricade and brush in closed trails with nearby vegetation.	Coarse and Fine Sediment: Unrestricted access to unmaintained or abandoned trails can result in rill and gully erosion and sediment delivery to waterbodies.	Turbidity OAR 340-041-0036
Dispersed Recreation		
Site camps for permitted group overnight camping would be greater than 100 feet from surface water.	Coarse and Fine Sediment: Soil disturbance close to streams can result in sedimentation. Lack of developed and maintained sanitation facilities poses a risk of fecal coliform contamination.	• Bacteria OAR 340-041-0009 • Turbidity OAR 340-041-0036

Grazing

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 278. Best management practices for grazing

Best Management Practices for Grazing	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Fence water developments, including springs and seeps, unless other methods are available. Pipe overflow away from the developed source area.	Coarse Sediment, Fine Sediment, Bacteria, Dissolved Oxygen, Temperature, and Biocriteria: Concentrated livestock use near/ within spring, seep areas resulting in overgrazing and subsequent loss of riparian vegetation, soil erosion, loss of shade and increases in summer stream water temperature, reduction in summer dissolved oxygen, delivery of bacteria and nutrients, with potential effects upon aquatic communities.	• Antidegradation OAR 340-04I-0004 • Bacteria OAR 340-041-0009 • Biocriteria OAR 340-041-0011 • Dissolved Oxygen OAR 340-041-0016 • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Do not locate salting areas within ¼ mile of permanent water sources or riparian management areas.	Coarse Sediment, Fine Sediment, Bacteria, Dissolved Oxygen, Temperature, and Biocriteria: Concentrated livestock use near/ within spring, seep areas resulting in overgrazing and subsequent loss of riparian vegetation, soil erosion, loss of shade and increases in summer stream water temperature, reduction in summer dissolved oxygen, delivery of bacteria and nutrients, with potential effects upon aquatic communities	• Antidegradation OAR 340-04I-0004 • Bacteria OAR 340-041-0009 • Biocriteria OAR 340-041-0011 • Dissolved Oxygen OAR 340-041-0016 • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
• Locate new livestock handling or management facilities (corrals, pens, or holding pastures) outside riparian management areas or 200 eet from waterbodies and on level ground where drainage would not enter surface waters. • If existing livestock handling facilities inside riparian management areas, do not meet water quality through use of BMPs, relocate or remove such facilities away from riparian management areas.	Coarse Sediment, Fine Sediment, Bacteria, Dissolved Oxygen, Temperature, and Biocriteria: Concentrated livestock use near/ within spring, seep areas resulting in overgrazing and subsequent loss of riparian vegetation, soil erosion, loss of shade and increases in summer stream water temperature, reduction in summer dissolved oxygen, delivery of bacteria and nutrients, with potential effects upon aquatic communities	• Antidegradation OAR 340-04I-0004 • Bacteria OAR 340-041-0009 • Biocriteria OAR 340-041-0011 • Dissolved Oxygen OAR 340-041-0016 • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036

Best Management Practices for Grazing	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Apply specific grazing strategies for riparian wetland areas, including timing, intensity, or exclusion for maintenance of proper functioning condition. Use one or more of the following features: • Inclusion of the waterbodies, floodplains, and wetlands within a separate pasture. • Fence or herd livestock out of waterbodies, floodplains, and wetlands for as long as necessary to allow vegetation to recover. • Control the timing of grazing to keep livestock off streambanks when they are most vulnerable to damage and to coincide with the physiological needs of target plant species. • Add more rest to the grazing cycle to increase plant vigor, allow streambanks to revegetate, or encourage more desirable plant species composition. • Limit grazing intensity to a level that will maintain desired species composition and vigor. • Permanently exclude livestock from those waterbodies, floodplains, and wetlands areas that are at high risk and have poor recovery potential, and when there is no practical way to protect them while grazing adjacent uplands.	Coarse Sediment, Fine Sediment, Bacteria, Dissolved Oxygen, Temperature, and Biocriteria: Concentrated livestock use near/ within spring, seep areas resulting in overgrazing and subsequent loss of riparian vegetation, soil erosion, loss of shade and increases in summer stream water temperature, reduction in summer dissolved oxygen, delivery of bacteria and nutrients, with potential effects upon aquatic communities	• Antidegradation OAR 340-04I-0004 • Bacteria OAR 340-041-0009 • Biocriteria OAR 340-041-0011 • Dissolved Oxygen OAR 340-041-0016 • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Recover degraded waterbodies through adjustments to forage utilization levels, improved livestock distribution, and management through fencing, vegetation treatments, water source developments, or changes in season of use or livestock numbers.	Coarse Sediment, Fine Sediment, Bacteria, Dissolved Oxygen, Temperature, and Biocriteria: Concentrated livestock use near/ within spring, seep areas resulting in overgrazing and subsequent loss of riparian vegetation, soil erosion, loss of shade and increases in summer stream water temperature, reduction in summer dissolved oxygen, delivery of bacteria and nutrients, with potential effects upon aquatic communities	• Antidegradation OAR 340-04I-0004 • Bacteria OAR 340-041-0009 • Biocriteria OAR 340-041-0011 • Dissolved Oxygen OAR 340-041-0016 • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036

Minerals Exploration and Development

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 279. Best management practices for minerals exploration and development

Best Management Practices for Minerals Exploration and Development	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
All Minerals		
Locate, design, operate, and maintain settling ponds to contain sediment discharges.	Coarse and Fine Sediment: Sediment could be transported to nearby streams from improperly designed or overflowing settling ponds.	Turbidity OAR 340-041-0036
Use existing roads, skid trails, and stream crossings.	Coarse and Fine Sediment: Potential sedimentation is reduced by minimizing new soil disturbance near streams.	Turbidity OAR 340-041-0036
Storm proof all natural surface roads and trails when an operation halts for the wet season. See Roads and Landings section for guidelines.	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbody.	Turbidity OAR 340-041-0036
Locate and maintain sanitation facilities where overflow or discharges would not enter surface water. Where possible, locate these facilities outside of riparian management areas.	Bacteria: Bacterial pollution from improperly constructed sanitation facilities could be injurious to the health of humans and aquatic organisms.	Bacteria OAR 340-041-0009
Locate structures and support facilities, including new roads, at least 200 feet from water bodies, floodplains, and wetlands.	Coarse Sediment, Fine Sediment, and Temperature: Developed sites can channel water and sediment into nearby waterbodies. Loss of riparian vegetation due to development could reduce shade and increase water temperature.	• Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Design, locate, and construct stream crossings in conformance with practices described in Roads and Landings section.	Coarse and Fine Sediment: Earthwork near streams can expose erodible soils and result in sedimentation to streams.	Turbidity OAR 340-041-0036
If roads are used during wet seasons with potential for sediment delivery to stream channels, rock aggregate would be used to surface those roads.	Coarse and Fine Sediment: Use of native surfaced roads during wet weather could result in unnecessary and undue degradation of water quality in nearby streams.	Turbidity OAR 340-041-0036
Prior to fall rains, reclaim all roads and trails constructed for exploratory purposes that are unnecessary for the mineral access.	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbody.	Turbidity OAR 340-041-0036
Retain an undisturbed riparian buffer strip between mineral operations and water bodies, floodplains, and wetlands.	Coarse Sediment, Fine Sediment, and Temperature: Protect integrity of streambanks, provide for water temperature control and for filtration of sediment from surface runoff	• Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036

Best Management Practices for Minerals Exploration and Development	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Stockpile available topsoil for use during reclamation of the site. Stockpiled topsoil would be stabilized to prevent erosion and contamination of other resources in the area.	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbodies.	Turbidity OAR 340-041-0036
On access roads to mineral sites where no future entry is planned, reclaim these access roads. This may include tilling, water barring, blocking, recontouring, fertilization, planting, mulching, and seeding.	Coarse and Fine Sediment: Soil erosion of exposed surfaces with potential transport to the channel, floodplain, or wetlands.	Turbidity OAR 340-041-0036
Reclaim depleted or closed mineral sites by stabilizing and contouring the mining area. Replace topsoil and mulch, seed, and plant.	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbodies.	Turbidity OAR 340-041-0036
Locate exploratory drill sites next to or on existing roads. Install erosion control structures to limit sediment transport off-site.	Coarse and Fine Sediment: Minimize soil disturbance to reduce potential for erosion and sediment delivery to streams.	Turbidity OAR 340-041-0036
Protect exposed soils from erosion by seeding, mulching, etc when constructing wells.	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbodies.	Turbidity OAR 340-041-0036
Locatable Minerals		
Comply with seasonal restrictions on suction dredging identified in Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources when discharging to Oregon's surface waters.	Coarse and Fine Sediment: Suction dredging can deposit fine sediment in gravels which is deleterious to fish and aquatic life. It can also be injurious to public health and recreation.	• Biocriteria OAR 340-041-0011 • Turbidity OAR 340-041-0036
Design new projects to contain waste products and prevent leaching contaminants from entering surface and ground water.	Toxic Substances: Mine generated waste and runoff can negatively impact surface or groundwater quality and impair aquatic habitat.	• Biocriteria OAR 340-041-0011 • Toxic substances OAR 430-041-0033
Do not locate toxic mine waste (e.g., waste rock, spent ore, or tailings) in riparian management areas.	Toxic Substances: Mine generated waste and runoff can negatively impact surface or groundwater quality and impair aquatic habitat.	Toxic substances OAR 430-041-0033
Reclaim mine waste after operations to ensure chemical and physical stability according to DOGAMI requirements.	Toxic Substances: Mine generated waste and runoff can negatively impact surface or groundwater quality and impair aquatic habitat.	• Toxic substances OAR 430-041-0033 • Turbidity OAR 340-041-0036
Stabilize exposed soils by seeding and mulching and provide for non-erosive drainage from disturbed areas that were constructed or renovated for mining activities.	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbodies.	Turbidity OAR 340-041-0036
When operating during the wet season, stabilize disturbed areas that will not be mined for at least 30 days.	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbodies.	Turbidity OAR 340-041-0036

Best Management Practices for Minerals Exploration and Development	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Prohibit surface occupancy within 200 feet of streams or other waterbodies.	Coarse Sediment, Fine Sediment, Temperature, and Bacteria: Developed sites can channel water and sediment into nearby waterbodies. Loss of riparian vegetation due to development could reduce shade and increase water temperature. Bacterial pollution could be injurious to the health of humans and aquatic organisms.	• Bacteria OAR 340-041-0009 • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Salable Minerals		
Locate stockpile sites on stable ground where the material would not move into waterbodies, floodplains, and wetlands.	Coarse and Fine Sediment: Placement of soil and rock stockpiles on unstable landforms can result in landslides with drainage of sediment-laden water to streams.	Turbidity OAR 340-041-0036
Locate, design, and construct salable mineral sites to minimize sedimentation to streams. Close roads, excavations and crusher pads in accordance with Roads and Landings section when the salable mineral site is depleted.	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbodies.	Turbidity OAR 340-041-0036
Do not develop or expand quarries within the riparian management area or within 200 feet of waterbodies, floodplains, and wetlands, whichever is greater.	Coarse Sediment, Fine Sediment, and Temperature: Developed sites can channel water and sediment into nearby waterbodies. Loss of riparian vegetation due to development could reduce shade and increase water temperature. Sedimentation in streams from road related runoff can impair aquatic habitat.	• Biocriteria OAR 340-041-0011 • Temperature OAR 340-041-0028 • Turbidity OAR 340-041-0036
Use culverts and rip-rap for crusher pad drainage when necessary.	Coarse and Fine Sediment: Effective drainage of surface runoff prevents sediment delivery to streams.	Turbidity OAR 340-041-0036
Use erosion-reduction practices, such as seeding, mulching, and woody debris placement, to limit erosion and transport of sediment to streams from quarries or other common variety mineral sites. Provide drainage from stockpiles and salable mineral sites that is dispersed over stable vegetated areas rather than directly into stream channels.	Coarse and Fine Sediment: Soil erosion of exposed surfaces with potential transport to the channel, floodplain, or wetlands.	Turbidity OAR 340-041-0036

Best Management Practices for Minerals Exploration and Development	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Limit collection of decorative rock to outside of riparian management areas and floodplains.	Coarse and Fine Sediment: Removing rock from the RMA or floodplain affects channel structure and results in a reduction in energy dissipation capability, potentially decreasing bank and floodplain stability during flood events, releasing stored fine sediment, and increasing the proportion of fine sediments in streams (removing the rocks, leaving the fines). Also, removal of large rocks within the RMA may necessitate the use of ground-based equipment that would cause soil disturbance and the potential for sediment delivery.	Turbidity OAR 340-041-0036
Leasable Minerals		
Stabilize roads, drill sites, and excavation areas to a free draining and non eroding condition from disturbed areas that are constructed or renovated for leasable mineral activities (e.g., roads, drill sites, and excavation areas).	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbodies.	Turbidity OAR 340-041-0036
When operating during the wet season, stabilize disturbed areas that will remain inactive for at least 30 days.	Coarse and Fine Sediment: Bare soil is subject to surface erosion and potential sediment delivery to adjacent waterbodies.	Turbidity OAR 340-041-0036
Line all mud pits that contain drilling fluid to prevent leaking.	Coarse and Fine Sediment: Drilling fluid can leak from unlined pits to surface and groundwater resources.	• Toxic substances OAR 430-041-0033 • Turbidity OAR 340-041-0036
Limit drill site construction and access through riparian management areas to established roadways unless the operator submits a plan that demonstrates that impacts to water quality from the proposed action can be adequately mitigated.	Coarse and Fine Sediment: Protect integrity of streambanks, provide for water temperature control and for filtration of sediment from surface runoff. Drilling and equipment fluids can negatively impact surface or groundwater quality and impair aquatic habitat.	• Temperature OAR 340-041-0028 • Toxic substances OAR 430-041-0033 • Turbidity OAR 340-041-0036

Spill Prevention and Abatement

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 280. Best management practices for spill prevention and abatement

Best Management Practices for Spill Prevention and Abatement	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Heavy Equipment Use		
• Require inspection and cleaning as necessary of heavy equipment prior to moving onto the project site in order to remove oil and grease, noxious weeds, and excessive soil. • Ensure that hydraulic fluid and fuel lines on heavy-mechanized equipment are in proper working condition. • Maintain and refuel equipment a minimum of 100 feet away from streams and other waterbodies. • In the event of a spill or release, all reasonable and safe actions to contain the material will be taken. Specific actions are dependent on the nature of the material spilled. • Use spill containment booms or as required by DEQ. Have booms and other absorbent containment materials on site and ready to deploy. • Immediately remove waste or spilled hazardous materials (including but not limited to diesel, oil, hydraulic fluid) and contaminated soils near any stream or other waterbody, and dispose of it/them in accordance with the applicable regulatory standard. Notify OERS of any spill over the material RQ, and any spill not totally cleaned up after 24 hours • Store equipment containing toxic fluids away from streams or other waterbodies.	Toxic Substances: Contaminants from equipment leaking into waterbodies.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Toxic Substances OAR 340-041-0033

Best Management Practices for Spill Prevention and Abatement	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Fuel and Chemical Transport		
If more than 42 gallons of fuel or combined quantity of petroleum product and chemical substances would be transported to a project site, the following precautions will be implemented. 1. Plan a safe route and material transfer sites so that all spilled material will be contained easily at that designated location. 2. Plan an active dispatch system that can relay the information to appropriate resources. 3. Ensure a spill containment kit that can adsorb and contain 55 gallons of petroleum product and chemical substances is readily available. 4. Provide for immediate notification to OERS in the event of a spill. Have a radio-equipped vehicle lead the chemical or fuel truck to the project site. 5. Assemble a spill notification list that includes the district hazardous materials coordinator, DEQ, and spill clean-up contractors. 6. Construct a downstream water user contact list with addresses and phone numbers. 7. When operating within Source Water watersheds, pre-estimate water flow travel times through the watershed to predict downstream arrival times. 8. Be prepared to sample water and carry sample containers. 9. Be prepared to assist OSP and ODFW assess wildlife impacts of any material spilled.	Toxic Substances: Chemical contamination of waterbodies.	• Antidegradation OAR 340-041-0004(1) • Biocriteria OAR 340-041-0011 • Statewide Narrative OAR 340-041-0007(1) and (13) • Toxic Substances OAR 340-041-0033
Spill Abatement		
Spill Prevention, Control, and Countermeasure Plan (SPCC): All operators shall develop a modified SPCC plan prior to initiating project work if there is a potential risk of chemical or petroleum spills near water bodies. The SPCC plan will include the appropriate containers to be used and design of the material transfer locations. No interim fuel depot or storage location other than a manned transport vehicle.	Toxic Substances: Chemical or petroleum product routing to water bodies.	[40 CFR 112] 42 U.S. Gallons for reportable quantities not involving waterways, a visible sheen where waterways are involved

Best Management Practices for Spill Prevention and Abatement	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Spill Containment Kit (SCK): All operators shall have a SCK as described in the SPCC plan on-site during any operation with potential for run-off to adjacent water bodies. The SCK will be appropriate in size and type for the oil or hazardous material carried by the operator.	Toxic Substances: Chemical or petroleum product routing to water bodies.	OAR-340-142-[0030]
Operators shall be responsible for the clean-up, removal, and proper disposal of contaminated materials from the site.	Toxic Substances: Chemical or petroleum product routing to water bodies.	• OAR-340-102-[inclusive] • OAR-340-122-[inclusive]

Restoration

See *Summary of Water Quality Standards* for additional details about the standards and regulations that are associated with the best management practices.

Table 281. Best management practices for restoration

Best Management Practices for Restoration	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Confine work in the stream channels to the low flow period.	Coarse and Fine Sediment: Concentrated turbidity and sedimentation potential due to channel disturbance during low flow conditions.	• Accumulation of bottom deposits OAR-340-041-0007 • Turbidity OAR-340-041-0036
In stream channels that are sensitive to disturbance (e.g., meadow streams), do not drive heavy equipment in flowing channels and floodplains.	Coarse and Fine Sediment: Disturbance of stream channel and streambanks resulting in erosion, sedimentation, turbidity, and loss of channel stability.	• Accumulation of bottom deposits OAR-340-041-0007 • Turbidity OAR-340-041-0036
In well armored channels that are resistant to damage (e.g., bedrock, small boulder, or cobble dominated), consider conducting the majority of heavy-equipment work from within the channel to minimize damage to sensitive riparian areas.	Coarse Sediment, Fine Sediment, and Temperature: Disturbance of floodplain and streambanks resulting in erosion, sedimentation, turbidity, and loss of stream shade.	• Turbidity OAR-340-041-0036 • Water Temperature OAR-340-041-0028
Design access routes for individual work sites to reduce exposure of bare soil and extensive streambank shaping.	Coarse and Fine Sediment: Soil erosion with potential transport to the channel and floodplain.	Turbidity OAR-340-041-0036
Confine heavy-equipment use in the streambed to the area necessary by working from the bank or a temporary structure for installation of structure to avoid flowing water.	Coarse and Fine Sediment: Excess disturbance of streambed and banks resulting in erosion, sedimentation and turbidity.	Turbidity OAR-340-041-0036
Limit the number and length of equipment access points through riparian management areas.	Coarse Sediment, Fine Sediment, and Temperature: Disturbance of floodplain and streambanks resulting in erosion, sedimentation, turbidity, and loss of stream shade.	• Turbidity • OAR-340-041-0036 • Water Temperature OAR-340-041-0028

Best Management Practices for Restoration	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Limit the amount of streambank excavation to the minimum necessary to ensure stability of enhancement structures. Provide isolation from flowing water during excavation. Place excavated material above the flood prone area and cover or place a berm to avoid its reentry into the stream during high flow events.	Coarse and Fine Sediment: Sedimentation during high flow events resulting in erosion, sedimentation and turbidity.	• Accumulation of bottom deposits OAR-340-041-0007 • Turbidity OAR-340-041-0036
Obtain logs for habitat restoration structures from outside the riparian management area or at least 100 feet from the stream channel.	Temperature: Removal of stream shade and future source of large woody material, loss of root stability on stream banks.	Water Temperature OAR-340-041-0028
Inspect all mechanized equipment daily for leaks and clean as necessary to help ensure that toxic materials, such as fuel and hydraulic fluid, do not enter the stream.	Oil, Gas, and Chemical Fluids: Direct entry of oil and gas into waterbody	Statewide Narrative Criteria Oil and Floating Solids OAR 340-041-0007
Equipment will not be stored in stream channels when not in use.	Oil, Gas, and Chemical Fluids: Direct entry of oil and gas into waterbody	Statewide Narrative Criteria Oil and Floating Solids OAR 340-041-0007
When using heavy equipment in or adjacent to stream channels during restoration activities, develop and implement an approved spill containment plan that includes having a spill containment kit on-site and at previously identified containment locations.	Oil, Gas, and Chemical Fluids: Direct entry of oil and gas into waterbody	Statewide Narrative Criteria Oil and Floating Solids OAR 340-041-0007
Refuel equipment, including chainsaws and other hand power tools, at least 100 feet from water bodies (or as far as possible from the water body where local site conditions do not allow a 150-foot setback) to prevent direct delivery of contaminants into a water body.	Oil, Gas, and Chemical Fluids: Direct entry of oil and gas into waterbody	Statewide Narrative Criteria Oil and Floating Solids OAR 340-041-0007
Use waterbars, barricades, seeding, and mulching to stabilize bare soil areas along project access routes prior to the wet season.	Coarse and Fine Sediment: Excessive turbidity and sedimentation to downstream areas due to erosion of disturbed soils.	Turbidity OAR-340-041-0036
Rehabilitate and stabilize disturbed areas where soil will support seed growth by seeding and planting with native seed mixes or plants, or using erosion control matting.	Coarse and Fine Sediment: Excessive turbidity and sedimentation to downstream areas due to erosion of disturbed soils.	Turbidity OAR-340-041-0036
When replacing culverts, install grade control structures (e.g., boulder vortex weirs or boulder step weirs).	Coarse and Fine Sediment: Excessive turbidity and sedimentation to downstream areas due to erosion of upstream sand/gravel/cobble deposits.	• Accumulation of bottom deposits OAR-340-041-0007 • Turbidity OAR-340-041-0036

Best Management Practices for Restoration	Input Variables and Causal Mechanisms	Water Quality Standards and Regulations
Rehabilitate headcuts and gullies.	Coarse and Fine Sediment: Excessive turbidity and sedimentation to downstream areas due to erosion of upstream sand/gravel/cobble deposits.	• Accumulation of bottom deposits OAR-340-041-0007 • Turbidity OAR-340-041-0036
Install turbidity control structures (e.g., isolation, diversioin, or silt curtains) immediately downstream of in-stream restoration work areas. Remove these structures following completion of turbidity generating activities.	Coarse and Fine Sediment: Excessive turbidity to downstream areas generated during instream structure placement.	Turbidity OAR-340-041-0036
Klamath Falls: During restoration projects involving juniper control or prescribed burns, design projects so that adequate soil cover remains (either by leaving cut trees in place for many years or by lopping and scattering branches); and adequate herbaceous seed source or seed bed is available (either naturally or through seeding), and ensure that subsequent management of the site addresses other limiting factors caused by management (e.g., livestock use or recreation).	Coarse and Fine Sediment: Soil erosion with potential transport to the channel and floodplain.	Turbidity OAR-340-041-0036

Summary of Oregon Water Quality Standards

This section summarizes the Oregon standards and regulations for water quality that are associated with the best management practices.

Statewide Narrative Criteria

The following are the Oregon administrative rules (OARs) for the statewide narrative criteria for water quality by name, number, and descriptive excerpt.

- **Antidegradation** (**OAR 340-04l-0004**)
  "The purpose of the Antidegradation Policy is to guide decisions that affect water quality such that unnecessary further degradation from new or increased point and nonpoint sources of pollution is prevented, and to protect, maintain, and enhance existing surface water quality to ensure the full protection of all existing beneficial uses."

  Note: The antidegradation policy applies to all 303(d) listed waterbodies when a project could further degrade the water quality.

- **Statewide Narrative Criteria Biological Criteria**
  (**OAR 340-041-0007**)
  "**(**11) The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or that are injurious to health, recreation, or industry may not be allowed."

- **Statewide Narrative Criteria Oil and Floating Solids**
  (**OAR 340-041-0007**)
  "(14) Objectionable discoloration, scum, oily sheens, or floating solids, or coating of aquatic life with oil films may not be allowed."

- **Statewide Narrative Criteria Road Building Waste Materials**
  (**OAR 340-041-0007**)
  "(9) Road building and maintenance activities must be conducted in a manner so as to keep waste materials out of public waters and minimize erosion of cut banks, fills, and road surfaces."

- **Statewide Narrative Criteria Sediment, Adverse Deposits**
  (OAR 340-041-0007)
  "(13) The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed."

- **Statewide Narrative Criteria Summary (OAR 340-041-0007)**
  "(1) Notwithstanding the water quality standards contained in this Division, the highest and best practicable treatment and/or control of wastes, activities, and flows must in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels."

Oregon Water Quality

For information about Oregon's water quality standards and a complete list of Oregon's administrative rules (OARs) for water quality, see http://www.deq.state.or.us/regulations/rules.htm. and http://www.deq.state.or.us/wq/standards/stanards.htm.

- **Statewide Narrative Criteria Toxics (OAR 340-041-0007)**
  "(12) The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish may not be allowed."

Statewide Numeric Criteria

The following are the Oregon administrative rules (OARs) for the statewide numeric criteria for water quality by name, number, and descriptive excerpt.

- **Bacteria (OAR 340-041-0009)**
  "(1) Numeric Criteria: Organisms of the coliform group commonly associated with fecal sources (MPN) or equivalent membrane filtration using a representative number of samples) may not exceed the criteria described in paragraphs (a) and (b) of this paragraph:
  (a) Freshwaters and Estuarine Waters Other than Shellfish Growing Waters:
  (A) A 30-day log mean of 126 *E. coli* organisms per 100 milliliters, based on a minimum of five (5) samples;
  (B) No single sample may exceed 406 *E. coli* organisms per 100 milliliters."

- **Biocriteria** (**OAR 340-041-0011**)
  "Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities."

- **Dissolved Oxygen (OAR 340-041-0016)**
  "Dissolved oxygen (DO): No wastes may be discharged and no activities must be conducted that either alone or in combination with other wastes or activities will cause violation of the following standards: The changes adopted by the Commission on January 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on January 10, 1996, apply:
  (1) For waterbodies identified as active spawning areas in the places and

times indicated on the following Tables and Figures set out in OAR 340-041-0101 to 340-041-0340: Tables 101B, 121B, 180B, 201B and 260B, and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B, 320B, and 340B, (as well as any active spawning area used by resident trout species), the Rules of this Division as last modified by the EQC 05/20/2004 following criteria apply during the applicable spawning through fry emergence periods set forth in the tables and figures:
(a) The dissolved oxygen may not be less than 11.0 mg/l. However, if the minimum intergravel dissolved oxygen, measured as a spatial median, is 8.0 mg/l or greater, then the DO criterion is 9.0 mg/l;
(b) Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 11.0 mg/l or 9.0 mg/l criteria, dissolved oxygen levels must not be less than 95 percent of saturation;
(c) The spatial median intergravel dissolved oxygen concentration must not fall below 8.0 mg/l.
(2) For waterbodies identified by the Department as providing cold-water aquatic life, the dissolved oxygen may not be less than 8.0 mg/l as an absolute minimum. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/l, dissolved oxygen may not be less than 90 percent of saturation. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 8.0 mg/l as a 30-day mean minimum, 6.5 mg/l as a seven-day minimum mean, and may not fall below 6.0 mg/l as an absolute minimum (Table 21);
(3) For waterbodies identified by the Department as providing cool-water aquatic life, the dissolved oxygen may not be less than 6.5 mg/l as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 6.5 mg/l as a 30-day mean minimum, 5.0 mg/l as a seven-day minimum mean, and may not fall below 4.0 mg/l as an absolute minimum (Table 21);
(4) For waterbodies identified by the Department as providing warm-water aquatic life, the dissolved oxygen may not be less than 5.5 mg/l as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 5.5 mg/l as a 30-day mean minimum, and may not fall below 4.0 mg/l as an absolute minimum (Table 21);
(5) For estuarine water, the dissolved oxygen concentrations may not be less than 6.5 mg/l (for coastal waterbodies).”

- **Temperature (OAR 340-041-0028)**
  "A. The seven-day-average maximum temperature of a stream identified as having salmon and steelhead spawning use may not exceed 55.4 degrees Fahrenheit. B. The seven-day-average maximum temperature of a stream identified as having core cold water habitat use may not exceed 60.8 degrees Fahrenheit. C. The seven-day-average maximum temperature of a stream identified as having salmon and trout rearing and migration use may not exceed 64.4 degrees Fahrenheit. D. The seven-day-average maximum temperature of a stream identified as having a migration corridor use may not exceed 68.0 degrees Fahrenheit."
- **Turbidity (OAR 340-041-0036)**
  "No more than a ten percent cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity."