Water

This analysis examines the effects of management actions on peak water flow and water quality in terms of water temperature and fine sediment.

Key Points
• In the rain-dominated hydroregion, the PRMP would have the highest number of subwatersheds susceptible to peak flow increases, and the No Action Alternative would have the fewest. However, the susceptibility to peak flows under all alternatives would be more similar to the effects of the No Harvest reference analysis than to the effects of the Intensive Management on the Most Commercial Timber Lands reference analysis. • In the rain-on-snow hydroregion, only three subwatersheds would be susceptible to peak flow increases in most time periods, which would be the same as under the No Harvest reference analysis. • None of the alternatives would affect stream temperature, because effective shade under all alternatives would be near potential natural shade. Under the No Action Alternative, Alternative 1, and the PRMP, the risk of natural tree mortality from blowdown that could affect stream shading would be lower than under Alternatives 2 and 3. • New road construction over the next 10 years under all alternatives would increase sediment delivery from roads less than 1% above current levels. . • Sediment inputs to streams from harvest-related landslides over time under all alternatives would be substantially similar to the amount that would occur under the No Harvest reference analysis.

This analysis makes frequent comparisons of the effects on peak flows and water quality under the alternatives to the effects under the No Harvest and Intensive Management on the Most Commercial Timber Lands reference analyses. As explained in the *Introduction* to *Chapter 4*, the reference analyses are not reasonable alternatives, because they would not meet the purpose and need for the action. The reference analyses provide points of comparison for the effects of the alternatives. Specifically in this analysis, the No Harvest reference analysis helps clarify which effects on the susceptibility to peak flow increases and the sediment from mass wasting would be the result of BLM actions, and which would be the result of natural processes or the actions of others. The Intensive Management reference analysis helps provide context for evaluating the magnitude of differences among the alternatives in susceptibility to peak flow increase over time.

As explained in *Chapter 3* (*Forest Structure and Spatial Pattern*), the classification of 2006 structural stage conditions differ slightly among the alternatives because of differences in how the inventory information is assembled for modeling under each alternative. The differences in the assembly of inventory information have a lesser effect on 2016 modeling results, and a negligible effect on modeling results for later years. Consistent with the descriptions of current conditions in *Chapter 3 (*in *Forest Structure and Spatial Pattern)*, this analysis uses the 2006 data from Alternative 3 for all alternatives. Therefore, the effects on peak flows and water quality in 2016 cannot be precisely compared to the 2006 data for some alternatives, for the sake of providing a consistent description of current conditions.

Peak Water Flow

This analysis evaluates the effect of timber harvest on increases to peak flows. Timber harvest would have the dominant influence on peak flow susceptibility from BLM actions, and can be addressed at this scale of analysis. This analysis evaluates the amount of timber harvest on all ownerships in sixth-field subwatersheds for each alternative at time periods of 10, 20, 50, and 100 years. The results of this analysis do not identify specific increases in peak flows that would depend on the timing and magnitude of future storms (which cannot be predicted) and site-specific conditions (which cannot be addressed at this scale of analysis). Instead, the results of this analysis describe susceptibility to peak flow increases at the subwatershed scale as a result of timber harvest.

Roads that extend the stream network can also influence the advances in the timing of water runoff or increases in peak flow (Wemple 1994, Jones and Grant 1996, and Grant et al. 2008). However, the effect of road construction on peak flow susceptibility is not included in this analysis, because new road construction under all of the alternatives would extend the stream network by less than 0.006 mile/mile of stream of the BLM's stream miles within the sediment delivery buffer along riparian areas. Analysis at this scale is not sufficiently sensitive to detect differences in changes in timing of peak flows that would result from this slight increase in the stream network.

In the rain-dominated hydroregion, timber harvesting influences peak flows only where a large proportion of the timber has been harvested within a short period of time in a watershed. The magnitude of the effect is scaled by the type of harvesting (thinning or regeneration harvesting) and the amount and distribution of harvesting at the stand level. It is also important to consider the treatment area in relation to watershed, scale, basin physical characteristics, and prior forest management history. After a harvested stand has re-established a substantial basal area, the area is considered hydrologically recovered. This usually occurs by the time a regenerated stand of timber is about 10 to 30 years in age (Miller and Burnett 2007, Stednick 1991). The stand establishment structural stage forest class is therefore used as a surrogate for open conditions where the majority of the basal area has been removed through timber harvesting.

Acres of stand establishment forests are shown in *Table 4-85 (Projected acres of stand establishment forests on BLM-administered lands).*

Grant et al. (2008) showed that for the rain-dominated hydroregion, 45% of an area harvested was the mean of the data when detectable peak flow effects appear in drainage areas with roads (see *Chapter 3-Water*). If this means that response level is used as a screen to determine peak flow susceptibility in the rain-dominated hydroregion, only two subwatersheds with BLM-administered lands would be susceptible under any alternative and any time period to a peak flow increase: Cooper Creek and Elk Creek-Flat Creek. Cooper Creek subwatershed on the Roseburg District is susceptible primarily because of the openness of the vegetation community type (oak savannah). Elk Creek-Flat Creek on the Medford District east of Brookings, Oregon, is currently susceptible because of the 2002 Biscuit fire, which burned approximately, 500,000 acres.

Based on experimental studies at the catchment scale, Grant et al. (2008) indicate that when 29% of an area is harvested in the rain-dominated hydroregion, detectable effects on peak flows in watersheds with roads begin to appear (see the *Water* section in *Chapter 3*). If this minimally detectable response level is used as a screen to determine peak flow susceptibility (instead of the mean response level used above), up to 12 subwatersheds with BLM-administered lands would be susceptible under any alternative in the

Table 4-85. Projected Acres Of Stand Establishment Forests On BLM-Administered Lands

Alternatives	Stand Establishment Forests on BLM-Administered Lands[a]									
	2006		2016		2026		2056		2106	
	acres	%	acres	%	acres	%	acres	%	acres	%
PRMP	155,000	7	229,000	10	259,000	12	296,000	13	214,000	10
Alternative 1	155,000	7	161,000	7	213,000	10	305,000	14	228,000	10
Alternative 2	155,000	7	213,000	10	295,000	13	431,000	20	319,000	15
Alternative 3	155,000	7	195,000	9	274,000	12	417,000	19	450,000	20
No Action Alternative	155,000	7	140,000	6	159,000	7	198,000	9	173,000	8

[a]Stand establishment acres are shown as a percent of BLM-administered lands, based on a gross forested area 2,197,000 acres.

rain-dominated hydroregion.[13] The number of susceptible subwatersheds at the 29% response level would vary among alternatives and over time. The effects of timber harvesting on peak flows in rain-dominated subwatersheds are shown in *Figure 4-139* (*Susceptible rain-dominated subwatersheds*) and in *Table 4-86* (*Rain-dominated sixth-field subwatersheds susceptible to increases in peak flows under the alternatives*).

Figure 4-139. Susceptible Rain-Dominated Subwatersheds

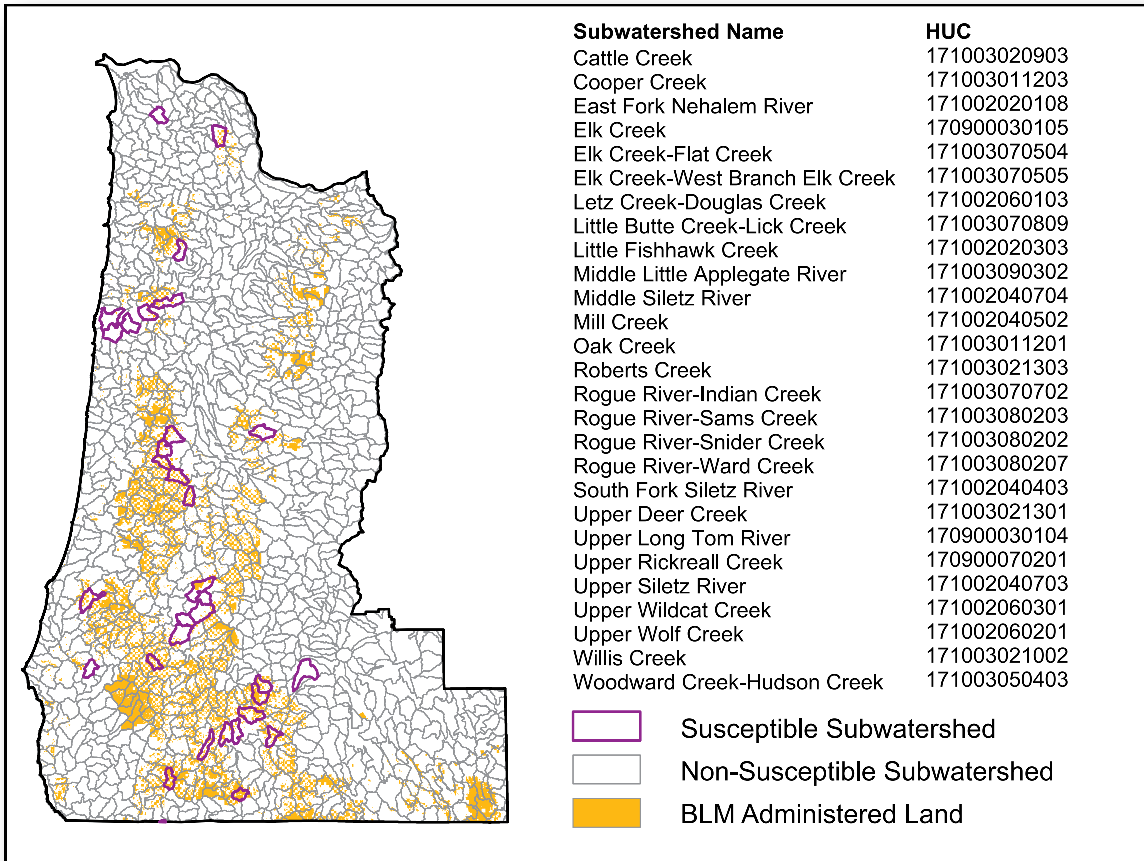


Table 4-86. Rain-Dominated Sixth-Field Subwatersheds Susceptible To Peak Flows Under The Alternatives

Alternative	Range of BLM Susceptible Subwatersheds (all time periods)	Total BLM Susceptible Subwatersheds, (all time periods)	Maximum Susceptible BLM Acres	Year That Maximum Susceptible BLM Acres is Reached[a]	Range of BLM Susceptible Acres (% of total subwatershed acres)
PRMP	9 to 12	18	12,000	2016	1. 8 to 6.6
Alternative 1	7 to 8	11	4,000	2016, 2026	0.5 to 2.6
Alternative 2	7 to 10	15	11,000	2026	1.3 to 5.3
Alternative 3	6 to 12	16	12,000	2106	1.7 to 5.0
No Action	5 to 8	9	4,000	2016	1.5 to 4.0
No Harvest	1 to 7	9	4,000	2016, 2026	0.5 to 2.7
Intensive Management	30 to 95	110	163,000	2056	3.5 to 9.0

[a]Year is based on the level and distribution of forest harvest.

[13]This analysis assumes that most non-BLM-administered lands would maintain their current amount of equivalent clearcut area (see Chapter 4 section on Forest Structure and Spatial Pattern). Future changes in the amount of equivalent clearcut area on non-BLM-administered lands and effects on peak flow susceptibility would be considered during the planning of implementation-level actions.

Table 4-86 shows the range of susceptible subwatersheds under the alternatives equaling and exceeding 29% equivalent clearcut area, which is the minimally detectable peak flow response level. A total of 27 out of 634 rain-dominated subwatersheds (4%) in the planning area with BLM-administered lands would be susceptible at time periods of 10, 20, 50, and 100 years. However, susceptibility varies with the pattern and intensity of timber harvest in subwatersheds over time, meaning that subwatersheds may be susceptible in some time periods, but not in other time periods. When compared to the other action alternatives, the PRMP would have the highest number of susceptible subwatersheds in any time period; the PRMP, Alternative 2, and Alternative 3 would have the greatest acreage of susceptible BLM-administered lands, but in different time periods. The No Action Alternative and Alternative 1 would have the fewest susceptible subwatersheds and the lowest acreage of susceptible BLM-administered lands. The range of affected BLM-administered lands would vary from 4 to 4,021 acres in any one subwatershed and time period. This represents between <0.1% to 16% of a total subwatershed area. When considering all ownerships and watersheds where there are no BLM-administered lands, up to 20 additional subwatersheds would be susceptible to increased peak flows.

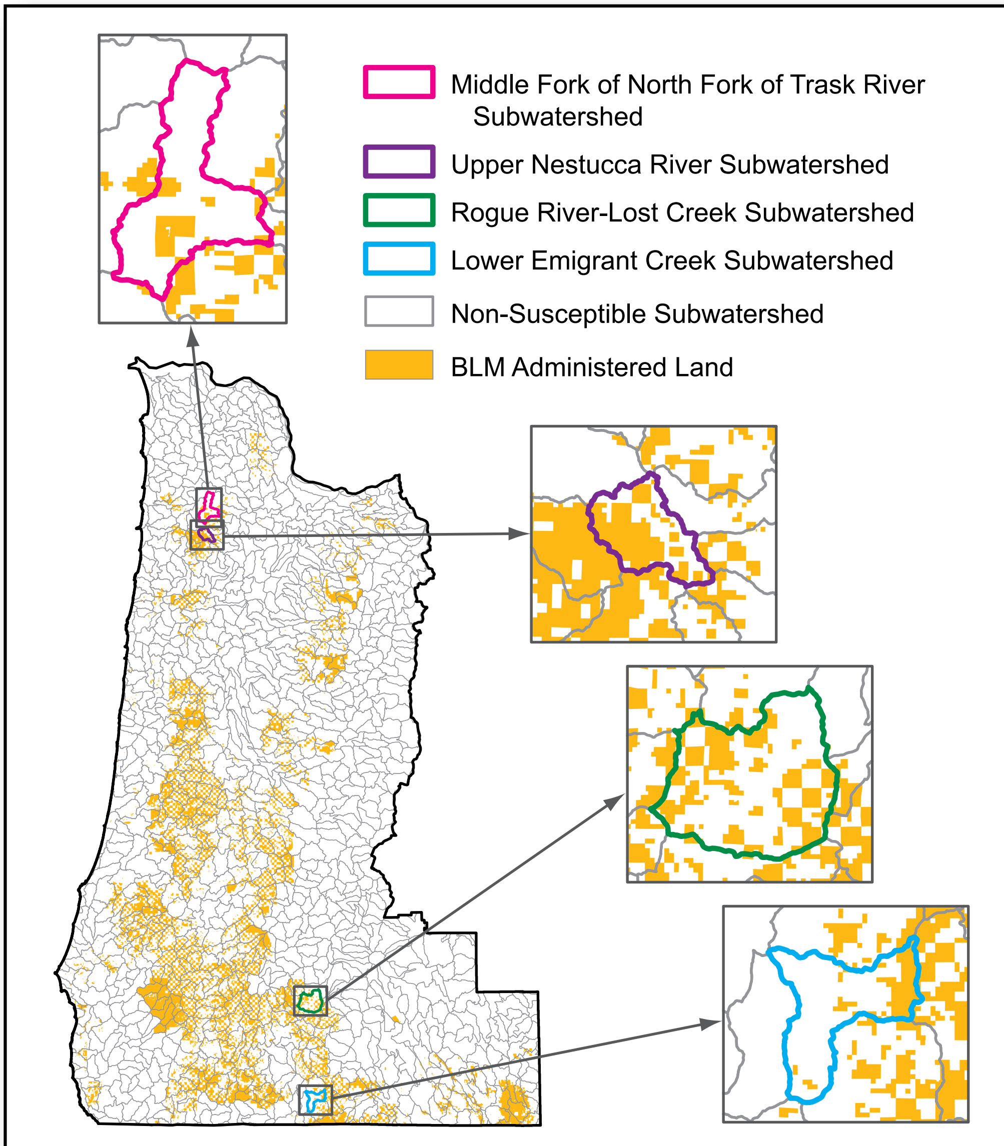
The No Harvest reference analysis indicates that, even in the absence of active management on BLM-administered lands, the number of susceptible subwatersheds in the rain-dominated hydroregion would be substantially similar to the No Action Alternative until 2056, after which the No Harvest reference analysis would be lower than the No Action Alternative. The Intensive Management on Most Commercial Timber Lands reference analysis indicates that intensive management on BLM-administered lands would increase the number of susceptible subwatersheds approximately three to ten times the number in the alternatives. The land use allocations and management direction under the alternatives limit the potential effect of timber harvest on susceptibility to peak flow increases in the rain-dominated hydroregion, so that the alternatives are more similar to the effects of the No Harvest reference analysis than to the effects of the Intensive Management on Most Commercial Timber Lands reference analysis.

In the rain-on-snow hydroregion, there would be three subwatersheds with BLM-administered lands out of 248 (1%) susceptible to peak flow increase over all time periods under all alternatives except under Alternative 2. Under Alternative 2, there would be one additional subwatershed (Middle Fork of North Fork of Trask River on the Salem District), susceptible for the 2056 time period. The effects of timber harvesting on peak flows in rain-on-snow-dominated subwatersheds are shown in *Figure 4-140 (Susceptible rain-on-snow-dominated sixth-field subwatersheds)*. See *Appendix I - Water* and the *Water* section in *Chapter 3* for a detailed description of methodology.

The No Harvest reference analysis indicates that, even in the absence of active management on BLM-administered lands, the number of susceptible subwatersheds in the rain-on-snow hydroregion would be the same as under all alternatives except Alternative 2. The Intensive Management on Most Commercial Timber Lands reference analysis indicates that intensive management on BLM-administered lands would result in one subwatershed more than the No Harvest reference analysis that would be susceptible in the 2026 and 2056 time periods.

Variations of climate can affect the melting of snow as stored water and peakflows during runoff events in the rain-on-snow hydroregion. To evaluate the sensitivity of these results to climate variations, the analysis also analyzed peak flow susceptibility using daily average air temperatures and wind speeds that are exceeded less than 2% of the time, instead of the average conditions used above (i.e., exceeded 50% of the time). Under these extreme conditions, 4 to 10 subwatersheds out of 248 (up to 4%) with BLM-administered lands would be susceptible to peak flow increases. This involves approximately 78,000 acres (3%) of BLM-administered lands within the planning area. There would be more affected subwatersheds under Alternatives 1, 2 and the PRMP during the 2026 and 2056 and 2106 time periods using these extreme climate conditions: there would be no difference under the No Action Alternative and Alternative 3. Green tree retention under the No Action and Alternative 3 in regeneration harvest units and partial

Figure 4-140. Susceptible Rain-On-Snow-Dominated Sixth-Field Subwatersheds



(Note: Peak flow susceptibility for sixth-field watersheds is where the 2-year, 24-hour bankfull channel forming peak flow is greater than the 5-year, 24-hour peak flow. Includes the current rate of harvesting on private land from the 1996 IVMP satellite imagery, applied to all time periods.)

harvesting under Alternative 3 would lessen the effect of increased wind speeds in the mechanics of rapid melt of shallow snowpacks, resulting in little difference in peak flow susceptibility under extreme climate conditions.

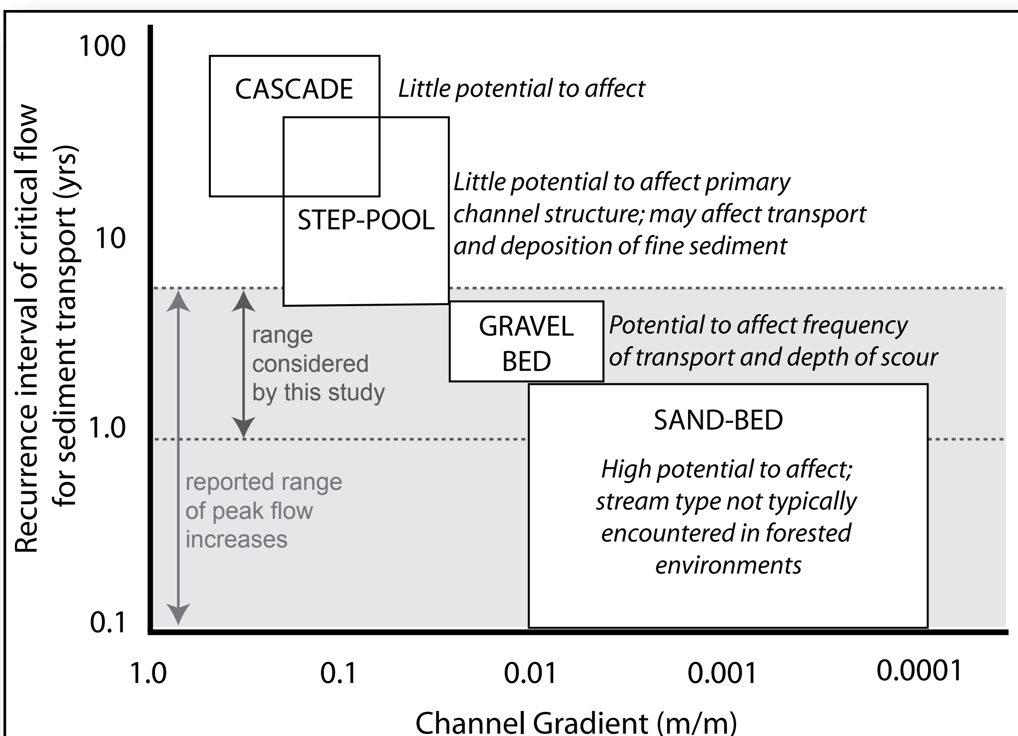
In the rain-on-snow hydroregion, variations in climate conditions would have more effect on susceptibility to peak flow increases than timber harvest. The similarity in peak flow susceptibility under the two reference analyses demonstrates that timber harvest on BLM-administered lands would not have any substantial effects on peak flow susceptibility in the rain-on-snow hydroregion that can be detected at this scale of analysis.

The results of this analysis that show some subwatersheds would be susceptible to increases in peak flows under the alternatives do not automatically imply adverse effects on stream form. This is because streamflow runoff normally fluctuates with climate, and channels have developed over time under a wide range of streamflows, including infrequent peak flows. Moreover, streamflow that return every one to six years have been shown to be detectable from the effects of forest management. These streamflows have the potential to affect the frequency of sediment transport and the depth of scour. *Figure 4-141* (*Potential for sediment transport based on channel gradient and return interval streamflow*) illustrates how potential peak flow effects would vary for different stream types (Grant et al. 2008). As seen in *Figure 4-141,* effects are not expected within the high gradient cascade and step-pool stream types. Approximately 80% of BLM streams are cascade and step-pool where short-term increases in peak flow would not be expected to cause changes. In pool/riffle stream types, with gravel-bed and sand substrates, increasing peak flows can rearrange the bed and banks. Where stream channels would be modified by increasing stream lows and stream energies high enough to cause bed and bank shear in susceptible subwatersheds, site-specific information regarding stream types and the resistance to streamflows would need to be evaluated at a project level to describe effects to stream form.

Mitigation of Peak Flows

For those alternatives that do not include green tree retention in regeneration harvest units, green tree retention would mitigate increased susceptibility to peak flow increases in the rain-on-snow hydroregion under extreme climate conditions, where project level analysis indicates susceptibility to peak flow increases from timber harvest. Green tree retention would reduce wind speed across regeneration harvest units and reduce snow accumulation in regeneration harvest units and thereby reduce the susceptibility under extreme climate conditions to the level of susceptibility under average climate conditions.

Figure 4-141 Potential For Sediment Transport, Based On Channel Gradient And Return Interval Streamflow



From Grant et al. 2008, used by permission

Other potential mitigation measures, such as altering the arrangement, distribution, timing, and patch size of regeneration harvest units within susceptible subwatersheds, cannot be evaluated at this scale of analysis. Whether adverse effects from peak flow increases would occur in any given sub-watershed from implementation-level actions and whether adverse effects could be lessened or avoided by such potential mitigation measures would depend on sub-watershed-specific conditions at the time of project implementation and would need to be considered in planning and design of implementation-level actions.

Water Quality

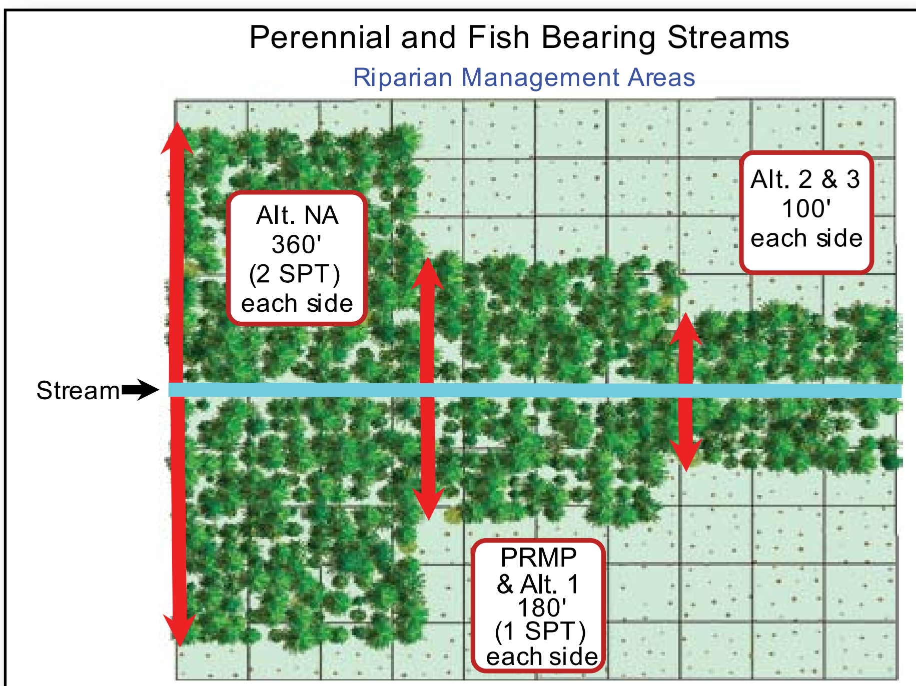
Shade and Stream Temperature

This analysis evaluates the effect of management activities on stream temperature by assessing the shading of perennial streams that would develop under the land use allocations and management direction of each alternative. As discussed in *Chapter 3 (Water* section*)*, solar radiation is the most important source of radiant energy that affects stream temperature, and the forest canopy that is nearest a stream blocks the majority of the solar radiation from reaching the stream. Eighty percent effective shade or greater is normally met within a 100-foot distance from the edge of the stream.

See *Figure 4-142 (Riparian Management Areas for permanently flowing streams)* for the width of the riparian reserves or the Riparian Management Areas along permanently flowing streams under the alternatives.

Under all alternatives, allocation of, and management direction for, the Riparian Management Areas (or riparian reserves) would result in the retention of sufficient shade during the summer months to avoid any measurable increase in water temperature. The area that would be allocated to Riparian

Figure 4-142. Riparian Management Areas For Permanently Flowing Streams



Note: SPT (site-potential tree) example shown for mid-range of conifer forest site productivity (site class III)

Management Areas (or riparian reserves) along perennial streams has already attained a forest structural condition that provides a high complement of shade: currently, 54% is mature or structurally complex, and less than 5% is stand establishment forest. Shade quality would further improve with time under all alternatives as stand establishment and young forests would decline in abundance, and mature and structurally forests would increase. Furthermore, under all alternatives, management direction for the Riparian Management Areas (or riparian reserves) would maintain the primary and secondary shade zones, and management direction would result in 80% effective shade or potential natural shade, whichever is less (see *Chapter 3 – Water* for definitions of the primary and secondary shade zones, and discussion of effective shade).

Under the No Action Alternative, Alternative 1, and the PRMP, the Riparian Management Area (or riparian reserve) width would extend beyond the primary and secondary shade zones. This additional width of Riparian Management Areas (or riparian reserves) would provide less than 5% increase in effective shade beyond the shading provided within 100 feet of streams. However, this additional width would provide a buffer against natural tree mortality from blowdown that could affect stream shading. Blowdown can occur anywhere in a Riparian Management Area or (riparian reserve), but may be more prevalent at the edge of the Riparian Management Area (or riparian reserve), particularly where high contrast edges exist between stand types (e.g., between mature forest and stand establishment forest). Steinblums et al. (1984) found that a riparian buffer of at least 120 feet from streams would maintain stream shading even where blowdown occurs. This is because the trees most likely to blow down would be outside the primary and secondary shade zones and would buffer the trees in the primary and secondary shade zones from the effects of wind. Under the No Action Alternative, Alternative 1, and the PRMP, the Riparian Management Area (or riparian reserve) width would extend beyond 120 feet from streams and, therefore, would maintain stream shading even where blowdown occurs.

Under Alternatives 2 and 3, the Riparian Management Area would not extend beyond the primary and secondary shade zones. Therefore, the Riparian Management Areas under Alternatives 2 and 3 would not provide a buffer against natural tree mortality from blowdown that could affect stream shading. The blowdown risk within Riparian Management Areas would increase where recent regeneration harvests would border Riparian Management Areas, creating an open area for wind acceleration and forest edges that face prevailing winds. Blowdown susceptibility along the edges of Riparian Management Areas would lessen as the new forest grows in the adjacent regeneration harvest area. Regeneration harvests would be distributed within and among watersheds over a range of topographies and proximities to Riparian Management Areas. Furthermore, a small portion of the BLM-administered lands would be in an open condition over time: the abundance of stand establishment forest would be no more than 20% of BLM-administered lands under Alternatives 2 and 3 over time (see *Chapter 4 – Forest Structure and Spatial Pattern* section). The dispersed pattern and limited abundance of open areas adjacent to Riparian Management Areas would limit the overall risk of blowdown affecting stream shading. Nevertheless, it is not possible to evaluate more precisely the blowdown risk because it is not possible to reasonably foresee the specific location, timing, or magnitude of future windstorms (see *Chapter 4 - Potential Changes in Conditions Not Incorporated into the Analysis* section). Also, there is insufficient information at this scale of analysis to evaluate the combined effects from the design of regeneration harvests adjacent Riparian Management Areas, topography and soils, and vegetation type and age.

Along perennial streams, tree falling for road construction and maintenance, timber harvest and restoration would occur within varying areas (described below) of the Riparian Management Areas (or riparian reserves) under all alternatives. These activities could alter reach level stream shading, but would have little potential to have broad-scale effects on stream shading.

Under all alternatives, thinning would occur within Riparian Management Areas (or riparian reserves). Restoration treatments under all alternatives would include felling trees in Riparian Management Areas (or riparian reserves) for alder or brush field conversions, or for treatment of forest diseases. Under all alternatives, thinning and restoration treatments would be highly dispersed and limited in extent because of the highly localized and limited conditions to which the treatments would be responding (see *Chapter 3 – Water* and *Fish* sections), and, therefore, would have little potential for broad-scale effects on stream shading. In addition, management direction under some alternatives would preclude broad-scale effects on stream shading:

- Under the No Action Alternative, thinning and restoration treatments would be designed to attain Aquatic Conservation Strategy objectives, which include maintaining and restoring water quality.
- Under Alternatives 2 and 3, thinning would be excluded within 25 feet of streams; thinning would maintain at least 80% effective or site-potential shade in the primary shade zone; and thinning would maintain at least 50% of the forest canopy cover after harvesting in the secondary shade zone.
- Under the PRMP, thinning would be excluded from the primary shade zone, and thinning would maintain at least 50% of the forest canopy cover after harvesting in the secondary shade zone.

Site-specific and highly localized effects on stream shading from thinning or restoration treatments would depend on site-specific stream and riparian conditions and the specific design of thinning or restoration treatments, which cannot be analyzed more precisely at this scale of analysis. Site-specific effects of thinning or restoration treatments on stream shading would be considered during the planning of implementation-level actions.

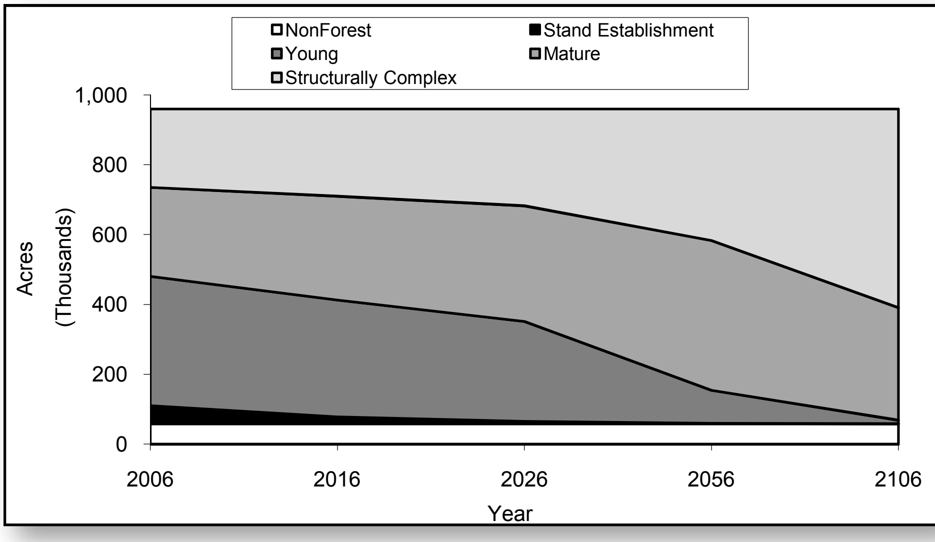
Tree felling or timber harvest for safety or operational reasons, such as danger tree removal, creation of yarding corridors adjacent to nearby harvest units, and road construction and improvement, would occur within Riparian Management Areas (or riparian reserves) under all alternatives. Such actions would be highly dispersed, limited in extent, and highly localized in their effects. Site-specific and highly localized effects on stream shading from tree falling or timber harvest for safety or operational reasons would depend on site-specific stream and riparian conditions and the specific design of tree falling or timber harvest, which cannot be analyzed more precisely at this scale of analysis. Site-specific effects of tree falling or timber harvest on stream shading would be considered during the planning of implementation-level actions.

Salvage harvest following natural disturbance within the Riparian Management Areas (or riparian reserves) would occur under all alternatives, but would not alter stream shading. Salvage harvest would cut trees that are dead or dying, and therefore the shading of these trees would have already been lost as a result of the natural disturbance. It is not possible to estimate the loss of stream shading from natural disturbance, because it is not possible to reasonably foresee the specific location, timing, or magnitude of future disturbances (see the section on *Potential Changes in Conditions Not Incorporated into the Analysis* in *Chapter 4*).

See *Figure 4-143 (Structural stage classes of the riparian reserves under the No Action Alternative)* for the distribution of acres by structural stage class within the riparian reserves. The preponderance of acres within the young high-density and mature forest structural stage classes indicates that the riparian areas currently have tree heights and crown areas that would provide effective shading. See the *Water* section in *Chapter 3*. There would be a gradual decline of the small percentage of stand establishment acres over time and would result in riparian forest structure that would improve shade quality as more acres move into the young and mature classes.

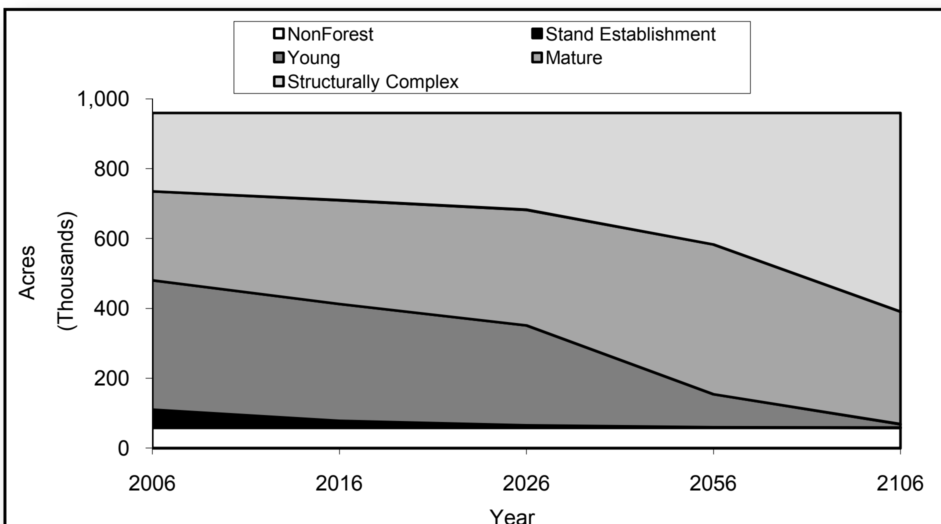
See *Figure 4-144* (*Structural stage classes of the Riparian Management Areas under Alternative 1)* and *Figure 4-145* (*Structural stage classes of the Riparian Management Areas under the PRMP)* for the distribution of acres by structural stage class within the Riparian Management Areas. The preponderance of acres within the young high-density and mature forest structural stage classes indicate that the riparian areas already have tree heights and crown areas that would provide effective shading. There would be a gradual decline in the amount of stand establishment acres over time, which would result in riparian forest structure that would improve shade quality as more acres move into the young and mature classes.

Figure 4-143. Structural Stage Classes Of The Riparian Reserves Under The No Action Alternative



See *Figure 4-146 (Structural stage classes of the Riparian Management Areas under Alternatives 2 and*

Figure 4-144. Structural Stage Classes Of The Riparian Management Areas Under Alternative 1



3) for the distribution of acres by structural stage class within the Riparian Management Areas. The preponderance of acres within the young stage which are high-density and mature forest structural stage classes indicate that the riparian areas already have tree heights and crown areas that would provide effective shading. There would be a gradual decline of the small percentage of stand establishment acres over time, which would result in riparian forest structure that would improve shade quality as more acres move into the young and mature classes.

The conclusions above regarding effective shade levels and effect on stream temperature do not include the management area adjacent to the Coquille Forest under Alternatives 2 and 3, where there would be an increase in stream temperatures following timber harvest. There are 31 miles of perennial streams on BLM-administered lands adjacent to the Coquille Forest, which include scattered land parcels totaling 10 miles

Figure 4-145. Structural Stage Classes Of The Riparian Management Areas Under The PRMP

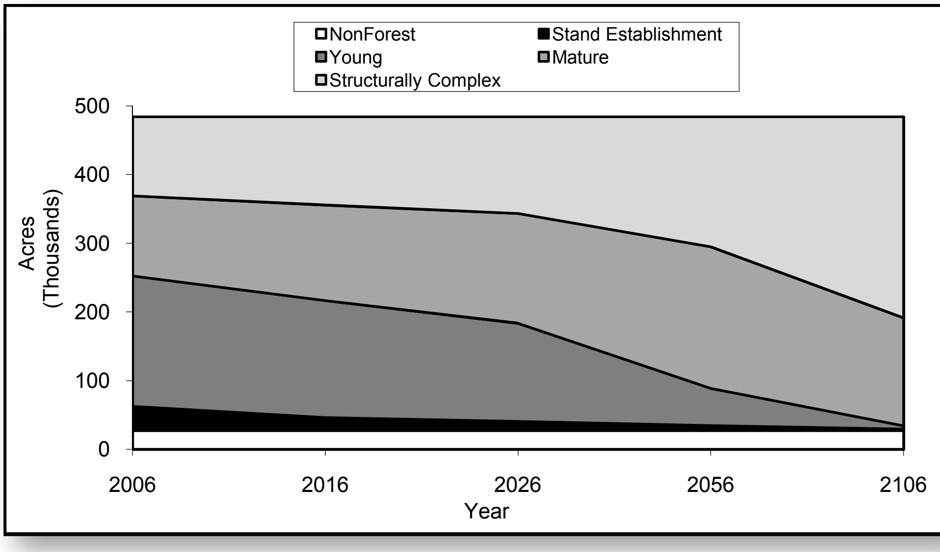
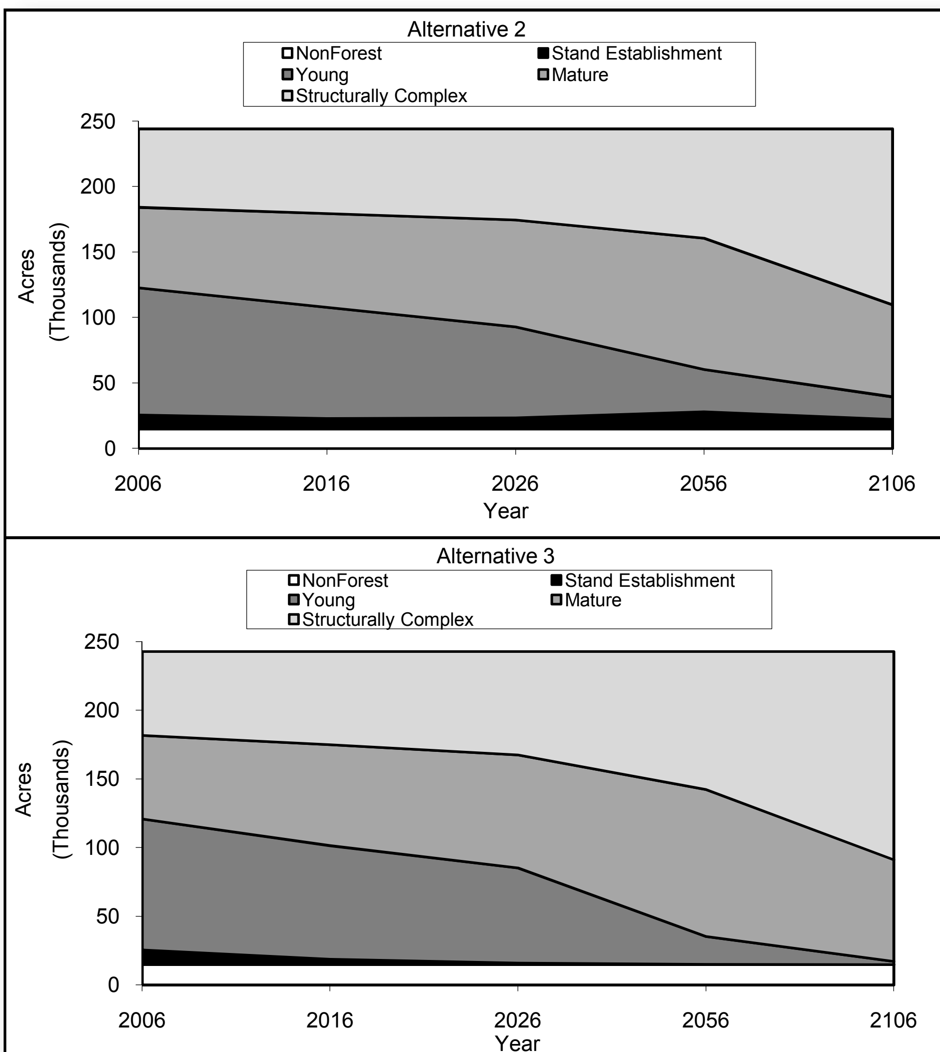


Figure 4-146. Structural Stage Classes Of The Riparian Management Areas Under Alternatives 2 And 3



within the East Fork Coquille watershed and 20 miles within the Middle Fork Coquille Watershed. Under Alternatives 2 and 3, sufficient trees in the primary shade zone would be retained to maintain 80% effective shade, but the secondary shade zone would decrease to 10-45 trees per acre after timber harvest. At 10 trees per acre retention, the secondary shade zone would provide relatively little shade, and the combined primary and secondary shade zone effective shade would decrease below a target of 80% effective shade by 10 to 20%. This reduction in shade would result in a stream temperature increase of up to 1°F per mile, because the combined primary and secondary shade zone effective shade quotient would be below 80% effective shade or potential natural shade. At 45 trees per acre retention, whether the combined primary and secondary shade zone effective shade would decrease below a target of 80% effective shade would depend on site-specific conditions. At all levels of retention, from 10 to 45 trees per acre, the magnitude of any increase in stream temperatures would depend on the pattern and extent of forest harvest within the Riparian Management Area secondary shade zone, as well as local site conditions; including stream orientation, topography, stream width, structure of the primary shade zone and other interrelated factors.

The conclusions above regarding effective shade levels and effect on stream temperature do not include riparian areas along waterbodies with infected or infested Port Orford cedar forest stands. Mortality of Port Orford cedar within riparian areas and effect on stream temperature change has been previously analyzed under the FSEIS Management of Port Orford Cedar in Southern Oregon 2004, which is incorporated by reference. This FSEIS concluded that Port Orford cedar infestations are limited to no more than 40 feet downslope from roads, except where streams or wet areas are present to facilitate further movement (USDA USFS and USDI BLM 2004: 3&4-76). Further, infestations of Port Orford cedar occur lineally, close to the stream channel. In a downstream direction high risk vectors for Port Orford cedar spread include water flowing in stream channels and connected off channel areas and floodplains. Predicted stream temperature increases from Port Orford cedar mortality were modeled within Appendix 9 of the FSEIS (USDA USFS and USDI BLM 2004: A-80). Results show that for small and large watersheds that worst case temperature increases of between 0.9-2.2 °F per mile would occur, where the first 15 feet of the streamside stand is completely killed.

Riparian-Wetlands on Eastside Management Lands

The Klamath Falls Resource Area includes rangeland riparian-wetland lands, including streams, marshes, wet meadows, and spring/seep areas, but varies greatly in extent and species composition on a west-east declining precipitation and elevation gradient with increasing arid rangelands. The Klamath Falls Resource Area Resource Management Plan and Environmental Impact Statement, which is incorporated by reference, describe these riparian-wetlands (USDI BLM 1994: 3-3,3-4, and 3-11–3-37). Riparian-wetland areas on the west side receive more precipitation and contain mostly conifer forests. Riparian-wetland areas on the east side are characterized by grasses and shrubs and do not have the vegetative potential to provide for more than limited shade. The Klamath Fall Resource Management Plan and Environmental Impact Statement concluded that the management actions in the 1994 RMP for east-side management lands would reduce adverse effects from livestock use in riparian-wetland areas; result in improvements in water temperature; provide protection of water quality; and improve watershed condition (USDI BLM 1994: 4-16-4-24).

The BLM expresses the status of riparian-wetland areas in terms of properly functioning condition and ecological status. Functioning condition is an important measure of the health of riparian-wetland conditions. Riparian management objectives are designed to improve properly functioning condition (see *Chapter 2 – Water* section).

To limit solar radiation exposure during the summer months, riparian-wetland communities would be managed for an upward trend under all alternatives, consistent with the prevalent community type and where ecologically appropriate. Depending on vegetation species height, density, width and physical aspects of the riparian-wetland area, a wide range of effective shade levels would result. On east-side lands, effective shade levels for most riparian-wetland areas would be considerably below 80% effective shade and stream warming would be occurring at a higher rate when compared to fully forested riparian-wetland areas elsewhere in the planning area. However, these riparian-wetland areas would reach system potential shade, when proper functioning condition and maximum upward trend is attained for the prevalent vegetation community type. Stream state, including degree of channel incision, width, depth, streambank stability, scour and deposition of sediments, and frequency of floodplain inundation would be evaluated along with riparian vegetation, because these physical attributes are related to proper functioning condition to determine an upward trend.

Sediment Delivery

This analysis focuses on sediment delivery to stream channels from roads and from landslides, because these sources would likely yield more fine sediment than other sources; are most likely to be affected by the management actions in the alternatives; and can be addressed at this scale of analysis.

Sediment delivery to streams as a direct result of timber harvest activities is not included in this analysis, because the potential delivery of sediment from these sources would be immeasurably small at this scale of analysis. Timber falling, yarding, ground-based skidding, and other land-disturbing practices associated with timber harvest have the potential to create fine sediment that could be delivered to streams. However, the combined effect of applying Best Management Practices that would prevent or contain deliverable sediments and the Riparian Management Areas (or riparian reserves) that would prevent surface soil disturbance and intercept and filter any deliverable sediments from timber harvest activities would limit or avoid delivery of fine sediment to streams as a result of timber harvest activities under all alternatives. Best Management Practices that prevent water quality degradation address timber harvest and associated management activities would be applied under all alternatives to prevent or contain deliverable sediments to a level that would be similar to that which would occur naturally (see *Appendix I - Water*). Specific Best Management Practices are identified to minimize or prevent sediment delivery to streams and waterbodies to a negligible level (e.g., log suspension over streams, ground based equipment limitation zones). Best Management Practices for individual forest management activities would be specified during the planning of implementation-level actions. Under all alternatives, the Riparian Management Area (or riparian reserves) would be of sufficient width to intercept and filter all or most of any fine sediment that could be created by timber harvest activities.

Rashin et al. (2006) found that for 157 erosion features that delivered sediment to streams where forest buffers were not present and that did not utilize any Best Management Practices, that 94% of them were closer than 33 feet (slope distance) from stream channels. All alternatives include Riparian Management Area (or riparian reserves) that are greater than 33 feet wide, except for intermittent stream channels that are not debris-flow prone under Alternative 2 and intermittent stream channels under Alternative 3. Under Alternatives 2 and 3, Riparian Management Areas along these intermittent stream channels would be 25 feet wide, which is most of the distance indicated by Rashin et al. (2006) as being effective to intercept and filter sediment. It is possible that timber harvest activities under Alternatives 2 and 3 near intermittent streams could result in some fine sediment delivery to streams, but only where application of Best Management Practices would not completely prevent sediment delivery. Whether specific timber harvest activities under Alternatives 2 and 3 near intermittent streams would result in fine sediment delivery and, if so, how much fine sediment delivery, would depend on site-specific stream and riparian conditions and the specific design of timber harvest activities and Best Management Practices, which cannot be analyzed more precisely at this scale of analysis.

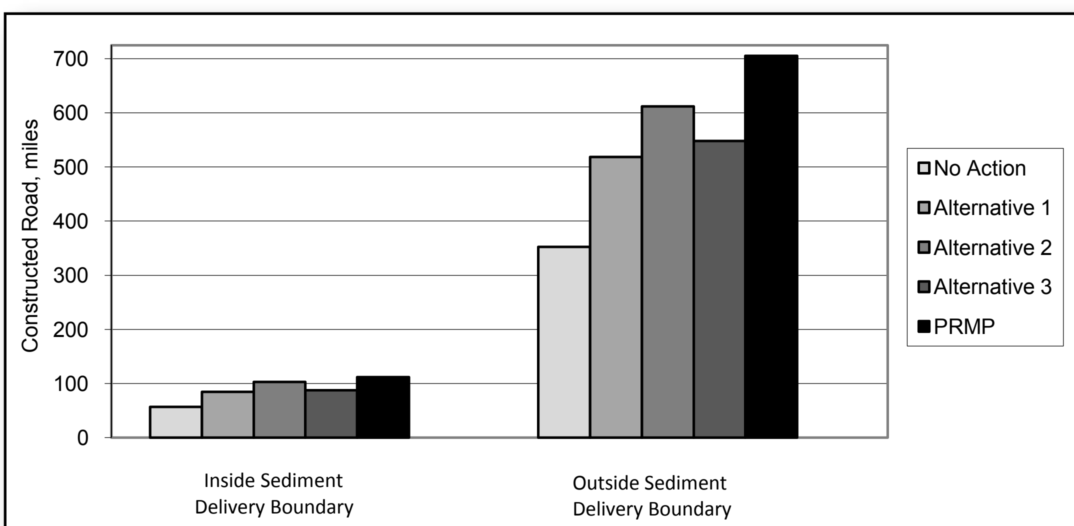
Sediment Delivery from Roads

This analysis is based on the use of a reference road (WA State DNR 1997) and the spatially-explicit road locations for new construction during the first decade. The road locations for new construction are derived from the 10-year scenario, in which modeled harvest units locations are mapped and BLM specialists develop road locations and harvest methods for the selected units (see *Appendix E - Timber*). The mapped harvest units in the ten-year scenario are a sample of the entire planning area, and road construction results were expanded from this sample to estimate results for the entire planning area. It is not possible to analyze the road construction in future decades, because identifying specific harvest units and road locations beyond the first decade would be too speculative to be informative. However, the mileage of road construction in future decades would generally decline from the first decade under all alternatives because as road density would increase over time, less new road construction would be required for timber harvest. Additionally, the proportion of timber harvest from thinning and the total harvest acres would decline in future decades under all alternatives (see *Chapter 4* – Timber). Therefore, the sediment delivery from roads for future decades under each alternative would generally be less than the amount analyzed here for the first decade.

Roads that are within a 200-foot delivery distance to streams are the primary sites in the Pacific Northwest for mobilizing chronic fine sediment to streams as concentrated ditch flow during heavy rainfall or snowmelt (see *Chapter 3 – Water* section). Under all alternatives, new roads would be located inside a sediment delivery distance to a lesser extent than upslope areas, because most primary transportation routes that parallel streams within a sediment delivery distance to streams have already been constructed. Timber planning harvest and road location projections in the first decade show that intrusions into the 200-foot sediment delivery zones and riparian areas surrounding streams would be limited to necessary stream crossings and shorter sections of road to access favorable upslope topography to forest stands where there would be no other reasonable routes. Approximately 36% of existing permanent roads on BLM-administered lands are within a 200-foot sediment delivery distance to streams. In contrast, an average of less than 2% increase (97 miles) in new permanent road construction under the alternatives would be within a 200-foot sediment delivery distance to streams. Moreover, there would be an average of less than 2% increase in roads within a sediment delivery distance to streams channels among the alternatives, compared to an average 6% increase in upland areas outside a sediment delivery distance for planned permanent roads. See *Figure 4-147* (*Projected newly constructed permanent roads within a sediment delivery distance to streams, compared to total newly constructed permanent roads by 2016).*

The incremental increase in fine sediment delivery from new road construction over the next 10 years would range from 1,567 tons/year under the No Action Alternative, to 2,811 tons/year under the PRMP. See *Table 4-87 (Potential delivery of fine sediment by new roads constructed by 2016 under the alternatives)* for the results for road segments that could contribute to fine sediment delivery over the next 10 years under each

Figure 4-147. Projected Newly Constructed Permanent Roads Within A Sediment Delivery Distance To Streams, Compared To Total Newly Constructed Permanent Roads By 2016



alternative. The current condition is shown for comparison. Under all alternatives, this increase would constitute less than a 1% increase in watersheds above current levels of fine sediment delivery from existing roads.

The increase in fine sediment delivery from new road construction over the next ten years would be lower under the No Action Alternative than all other alternatives, because fewer miles of road would be

Table 4-87. Potential Delivery Of Fine Sediment By New Roads Constructed By 2016 Under The Alternatives

Current Condition and Condition under the Alternatives by 2016	Roads Within Fine Sediment Delivery Distance (miles)		Potential Fine Sediment Delivery (tons/year)[a]		Watershed Average Potential Fine Sediment Delivery (tons/square mile/year)[b]	
Existing Roads[c]	Current Condition					
	BLM	Other	BLM	Other	BLM	Other
Natural	1,738	15,874	23,050	233,054	0.86	8.75
Aggregate	2,590	22,938	28,938	30,765	1.09	1.15
Paved	767	2,436	8,277	33,807	0.31	1.27
Totals	**5,096**	**21,249**	**60,265**	**297,626**	**2.8**	**11.3**
New Roads (by 2016)[d]	No Action Alternative					
Natural	11.5		326		0.01	
Aggregate	45.4		1241		0.05	
Paved	0.0		0		0	
Totals	**56.9**		**1,567**		**0.06**	
New Roads (by 2016)	PRMP					
Natural	30.4		857		0.03	
Aggregate	81.5		1,954		0.07	
Paved	0		0		0	
Totals	**112.9**		**2,811**		**0.10**	
New Roads (by 2016)	Alternative 1					
Natural	15.6		421		0.02	
Aggregate	69.9		1,725		0.06	
Paved	0		0		0	
Totals	**85.5**		**2,146**		**0.08**	
New Roads (by 2016)	Alternative 2					
Natural	13.3		404		0.02	
Aggregate	89.7		1,859		0.07	
Paved	0		0		0	
Totals	**103**		**2,263**		**0.09**	
New Roads(by 2016)	Alternative 3					
Natural	16.0		436		0.02	
Aggregate	71.4		1,655		0.06	
Paved	0		0		00	
Totals	**87.4**		**2,091**		**0.08**	

[a]Delivery distances include the road segments within 200 feet of stream channels, where ditchflow carrying fine sediment could enter streams.
[b] These estimates were calculated by surface type for each fifth-field watershed and summed for the planning area.
[c] BLM includes the BLM-controlled roads and the private roads within the planning area from BLM GIS GTRN (roads) coverage.
[d]Includes BLM new roads only. Information is not available to predict the number of miles of new roads on other lands.

constructed over then next ten years within the sediment delivery distance to streams. Fine sediment delivery would be similar under Alternatives 1, 2, and 3 even though Alternative 2 would have the highest timber harvest volume of all alternatives. Alternative 2 would have a greater proportion of regeneration harvest to thinning harvest than the other alternatives (see *Chapter 4 – Timber*), and regeneration harvest requires less road construction than thinning. Additionally, most new road construction under Alternative 2 would be short extensions of existing roads in upslope areas because of the prevalence of regeneration harvest and conventional logging systems generally yard uphill.

The increase in fine sediment delivery from new road construction over the next 10 years would be greater under the PRMP than all other alternatives because of the greater acreage of thinning under the PRMP (see *Chapter 4 – Timber*), that would require more road construction than regeneration harvest. Additionally, the PRMP would include approximately twice the length of permanent natural surface road within the 200-foot sediment delivery distance than the other alternatives. Natural surface road would yield higher sediment delivery per mile than aggregate road in typical topography near streams (See *Chapter 3 – Water*).

Under all alternatives, Best Management Practices would be applied to the design of permanent and temporary road construction (see *Appendix I - Water*) to maintain or improve water quality. The Best Management Practices include methods that limit the delivery of sediment to streams. These practices would be applied during such management activities as timber harvesting, road maintenance and construction, road decommissioning, energy and mineral development, and fuel treatments.

Some of the Best Management Practices that are related to roads include:

- Design transportation system to limit the number of new roads and reduce the stream fine sediment delivery points to the extent practicable.
- Design new stream crossings to pass flows of water, sediment and debris without overtopping or failure.
- Improve road systems to reduce the flow of concentrated water and entrainment of fine sediment in roadside ditches by increasing the frequency of drainage relief culverts.
- Disconnect road flow paths from streams by performing road restoration actions where roads are permanently decommissioned.

These results in *Table 4-87* over-estimate the fine sediment delivery from new road construction under all alternatives, because the basic erosion rates for new roads would decrease typically as much as 50% after two years of construction as a result of vegetation establishment along cut and fill slopes (see *Chapter 3-Water*). Therefore, the expected sediment delivery to streams would decrease rapidly after road construction and stabilization. The average sediment delivery to streams from new road segments being constructed in different years during the first decade while others are re-vegetating during the same period means that there would be less sediment delivery from road than the results reported in *Table 4-87* for all alternatives. The effect of vegetation establishment in reducing sediment delivery from roads would depend on site-specific conditions and the specific road design, which cannot be analyzed more precisely at this scale of analysis. Therefore, the reduction in sediment delivery after road construction from vegetation establishment cannot be quantified in this analysis.

This analysis assumes that approximately 270 miles of road decommissioning, 38,115 miles of road maintenance, and 2,184 miles of road improvement per decade would occur under all alternatives. This assumed level of road decommissioning is based on the level of activity that has occurred under the 1995 resource management plans adjusted for the anticipated reduction in opportunities for decommissioning in the future (see *Chapter 4 – Fish*). All alternatives include management direction to decommission roads specifically to reduce chronic sediment inputs, but it is not possible to identify specifically where future road decommissioning would occur. If future road decommissioning were to occur within the sediment delivery distance proportional to the total abundance of new BLM roads within the sediment delivery distance, 97 miles of road within the sediment delivery distance would be decommissioned each decade under all alternatives. *Table 4-87* shows that 5,096 miles (36%) of the 14,273 miles of total BLM's roads occur within a sediment delivery distance. On a proportional basis, 97 miles (i.e., 36% of 270 miles) of roads within the sediment delivery distance would be decommissioned each decade under all alternatives.

Therefore, there would be little net increase in road miles within a 200-foot sediment delivery distance under Alternative 2 and the PRMP, and a net decrease in road miles under the other alternatives. See *Figure 4-147* (*Projected newly constructed permanent roads within a sediment delivery distance to streams, compared to total newly constructed permanent roads by 2016).* This likely under-estimates the amount of road decommissioning that would occur within the sediment delivery distance because management direction under all alternatives directs road decommissioning to reduce chronic sediment inputs to streams. The specific effects of road decommissioning on sediment delivery from roads would depend on site-specific conditions of roads, streams and riparian areas and the specific design of road decommissioning, all of which cannot be analyzed more precisely at this scale of analysis. Nevertheless, the estimated road decommissioning within the sediment delivery distance would result in an immeasurably small increase in sediment delivery from BLM roads under the PRMP and Alternative 2 and a net decrease in sediment delivery from BLM roads under the No Action Alternative, Alternative 1, and Alternative 3.

Sediment Delivery from Mass Wasting

This analysis evaluates the effects of management activities on sediment delivery from mass wasting by calculating a relative landslide density that indicates the expected amount of landslides that could deliver sediment to streams. Mass wasting refers to any down-slope movement of a mass of sediment or rock. This analysis will specifically address shallow, colluvial landslides that occur when loose, heterogeneous soils on steep slopes become saturated and slide. Shallow, colluvial landslides ("landslides" hereafter) are the type of mass wasting most likely to be affected by the management actions in the alternatives and can be addressed at this scale of analysis. Landslides can occur in all forest types, but not in all forest locations. Some portions of the landscape are not prone to landslides, regardless of management actions. On landslide-prone portions of the landscape, timber harvest can increase the probability of landslide, but only if a damaging storm occurs in the vegetation re-growth period: up to 10 years following harvest (see *Chapter 3 – Water*).

This analysis calculates an average relative density of landslides that could deliver to a stream channel in the planning area from BLM-administered lands using geospatial and analytical methods developed by Miller and Burnett (2007). Topographic weighting functions were developed for the Coast Range Cascades, and Klamath Provinces. Vegetation was classified into recent regeneration harvest (<10 years), mixed forest and hardwoods (10-100 years) and older forest (>100 years). The relative landslide density was calculated for all combinations of topography and classified vegetation, including the susceptibility from roads. Because this analysis is designed to evaluate the delivery of sediment to streams, the relative landslides density includes only those areas that could deliver to stream channels, based on the model calibration described in Miller and Burnett (2007) (see *Appendix I – Water)*. The relative landslide density is an indication of the expected amount of landslides for a time period, based on a calibration dataset. For this analysis, the calibration time period is the expected relative landslide density based on 1996 floods, which were extreme storms that have a return interval of 70-100 years (see *Chapter 3 - Water*).

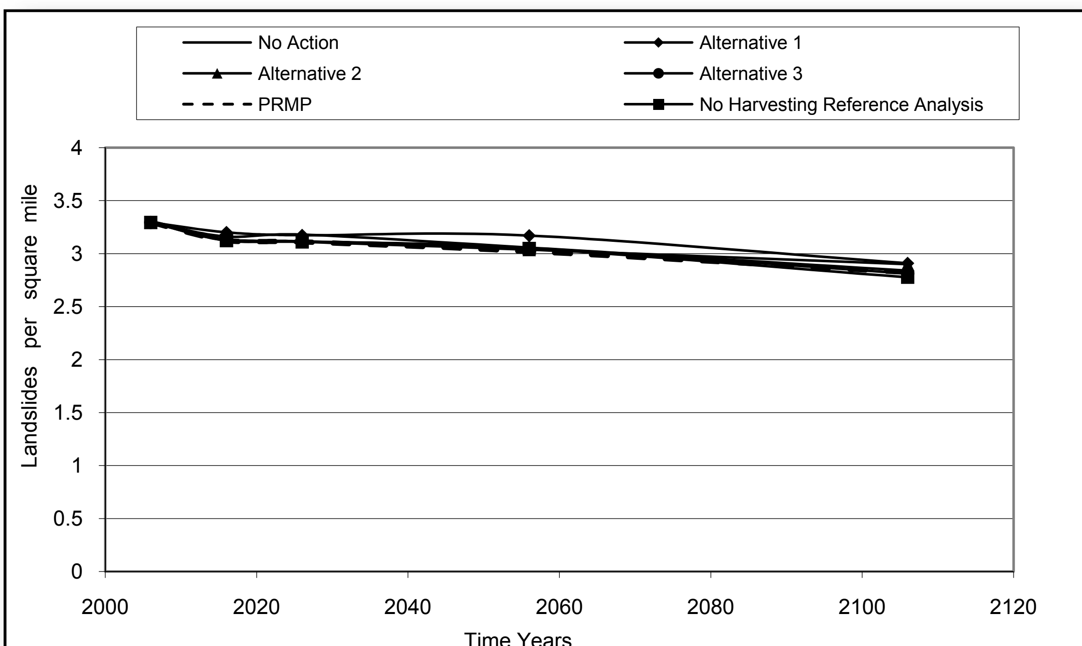
It is not possible at this scale of analysis to quantify the amount of sediment that would be delivered from landslides to streams over time under each of the alternatives. The amount of sediment delivered to streams from landslides would depend on the volume of each landslide and site-specific geologic and topographic factors, which cannot be addressed at this scale of analysis. The relative landslide density provides a basis to compare qualitatively the potential sediment delivery among the alternatives, and to compare the effects of the alternatives to current conditions and to the potential sediment delivery that the No Harvest reference analysis indicates would occur in the absence of active management.

Over the planning timeframe, relative landslide density across the planning area would decline from the current condition under all alternatives, in part because the abundance of older forest would increase under all alternatives.

In all provinces, relative landslide density across all land use allocations would decline from the current condition by 2106. Similar to the current condition, relative landslide density over time would remain highest in the Klamath Province, slightly lower in the Coast Range, and substantially lower in the Cascades Province[14] (see *Figures 4-148, 4-149,* and *4-150*). In the Coast Range Province by 2106, relative landslide density would range from 2.8 landslides per square mile under Alternative 3, to 2.9 landslides per square mile under Alternative 1. In the Cascades Province by 2106, relative landslide density would range from 0.6 landslides per square mile under the PRMP, to 0.7 landslides per square mile under Alternative 1. In the Klamath Province by 2106, relative landslide density would range from 3.6 landslides per square mile under Alternative 2, to 4.0 landslides per square mile under Alternative 1. In the Klamath Province, relative landslide density under Alternative 1 would slightly increase from current conditions until 2056, and then would decline to below current conditions by 2106; this is the only alternative in any province during any timber period under which relative landslide density would increase from current conditions. The No Harvest reference analysis indicates that, even in the absence of active management on BLM-administered lands, the relative landslide density by 2106 would be 2.8 landslides per square mile in the Coast Range Province; 0.6 landslides per square mile in the Cascades Province and 3.5 landslides per square mile in the Klamath Province.

There is little if any correlation between relative landslide density under the alternatives over time and the acres of timber harvest under the alternatives. For example, in the Klamath Province, Alternative 1 and the No Action Alternative would have the highest relative landslide density and would have the lowest Allowable Sale Quantity of any alternatives; Alternative 2 and the PRMP would have the lowest relative

Figure 4-148. Relative Landslide Density by Alternative Across All Land-Use Allocations That Would Deliver To Stream Channels (Coast Range Province)



[14]The "Cascades Province" in this analysis includes the West Cascades, East Cascades, and Willamette Valley Provinces.

Figure 4-149. Relative Landslide Density By Alternative Across All Land-Use Allocations That Would Deliver To Stream Channels (Cascades Province)

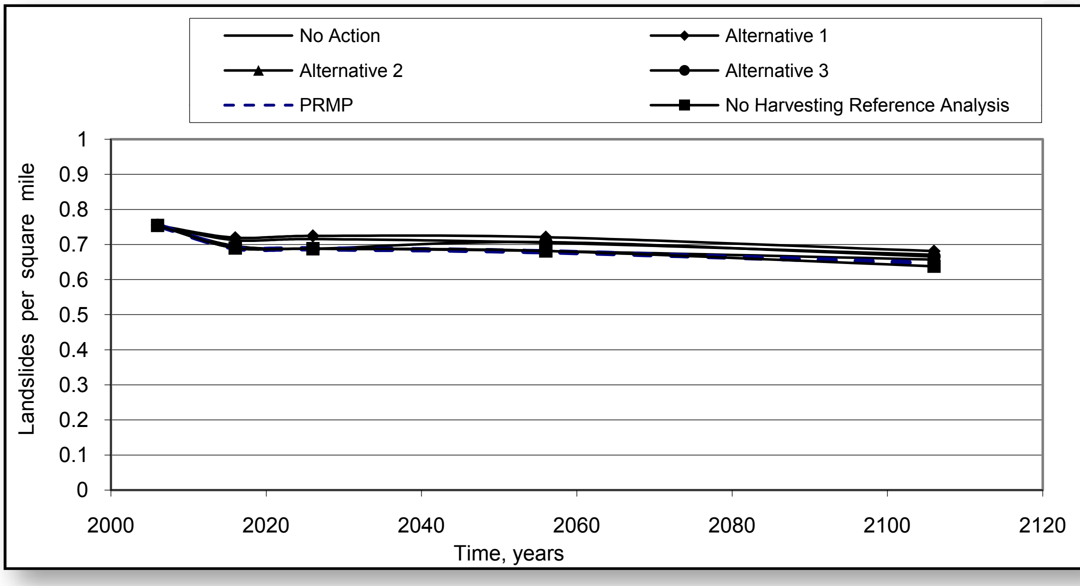
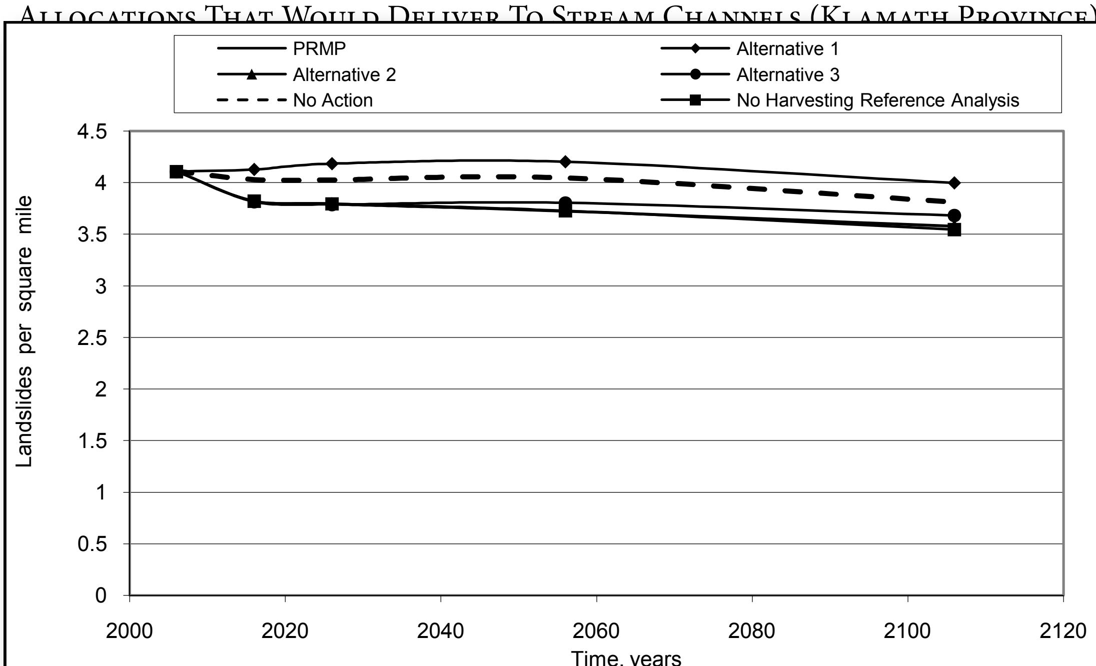


Figure 4-150. Relative Landslide Density By Alternative Across All Land-Use Allocations That Would Deliver To Stream Channels (Klamath Province)



Relative landslide densities are weighted averages, as modeled by Miller 2008, for non-forest, recent harvest areas, young forest, and older forest for a set of watersheds comprising each province. Landslide delivery is to stream channels <20% gradient.

landslide density and would have the highest Allowable Sale Quantity (see *Chapter 4 – Timber*). In each province, the relative landslide density under at least one alternative would be virtually indistinguishable from what the No Harvest reference analysis indicates would occur in the absence of active management: the PRMP and Alternative 2 in the Klamath Province; the PRMP and Alternative 3 in the Coast Range Province; and the PRMP in the Cascades Province. In all provinces, the PRMP would have approximately the same relative landslide density as the No Harvest reference analysis, yet the PRMP would have an Allowable Sale Quantity higher than all alternatives except Alternative 2.

Within the harvest land base under each alternative, the relative landslide density would show different patterns than the pattern across all land use allocations:

- In the Coast Range Province, the relative landslide density within the harvest land base under Alternative 1 and the No Action would fluctuate, increasing temporarily above current conditions, and then decreasing after 2056 to approximately the current levels under Alternative 1 and to below current conditions under the No Action Alternative. The relative landslide density within the harvest land base under Alternatives 2 and 3 and the PRMP would decrease from the current conditions. See *Figure 4-151 - Relative landslide density by alternative in the harvest land base that would deliver to stream channels; Coast Range Province.*
- In the Cascades Province, the relative landslide density within the harvest land base under Alternative 1 and the No Action Alternative would increase until 2026 and then slightly decrease until 2106, but still remain above current conditions. The relative landslide density within the harvest land base under Alternatives 2 and 3 and the PRMP would decrease from the current conditions. See *Figure 4-152 - Relative landslide density by alternative in the harvest land base that would deliver to stream channels; Cascades Province.*
- In the Klamath Province, the relative landslide density within the harvest land base under Alternative 1 and the No Action Alternative would increase until 2056 and then decrease until 2106, but still remain above current conditions. The relative landslide density within the harvest land base under Alternatives 2 and 3 and the PRMP would decrease from the current conditions. See *Figure 4-153 - Relative landslide density by alternative in the harvest land base that would deliver to stream channels; Klamath Province.*

Figure 4-151 Relative Landslide Density By Alternative In The Harvest Land Base That Would Deliver To Stream Channels (Coast Range Province)

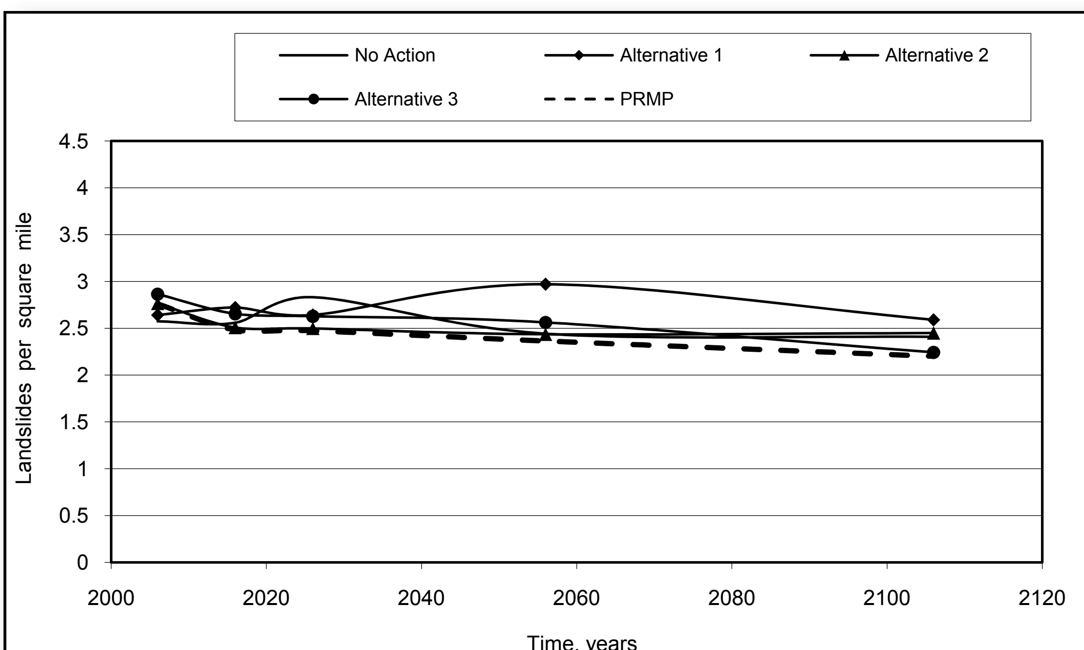


Figure 4-152 Relative Landslide Density By Alternative In The Harvest Land Base That Would Deliver To Stream Channels (Cascades Province)

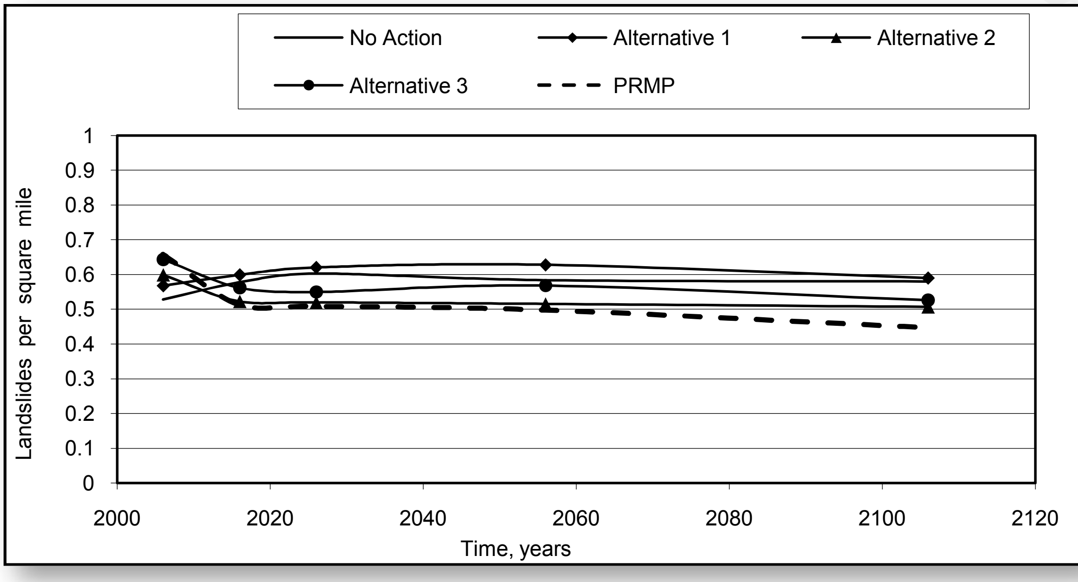
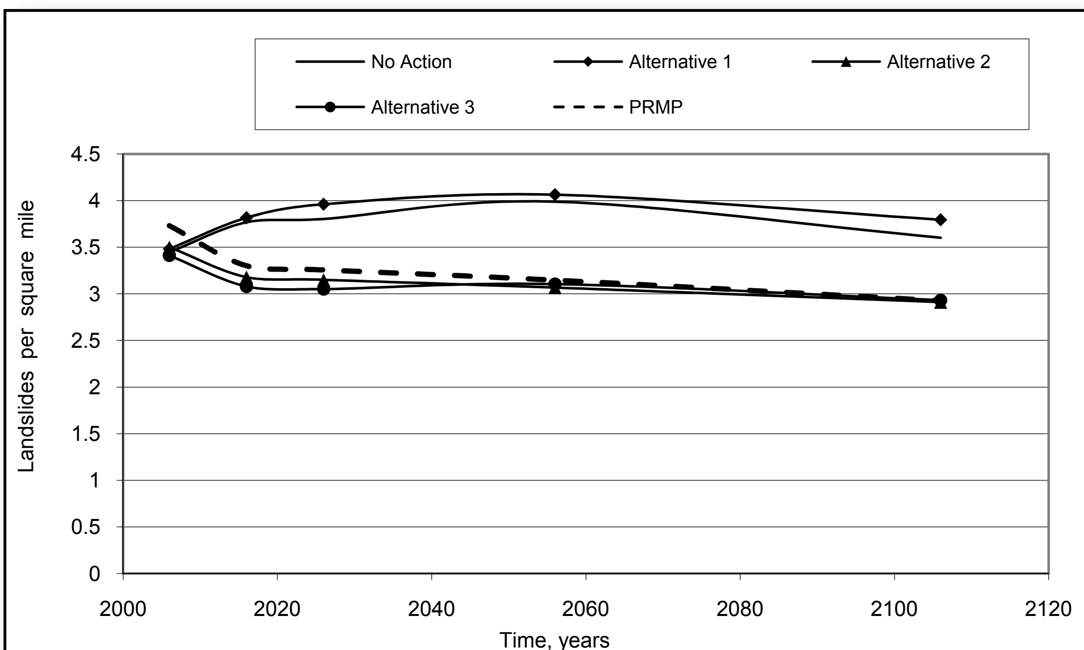


Figure 4-153 Relative Landslide Density By Alternative In The Harvest Land Base That Would Deliver To Stream Channels (Klamath Province)



Relative landslide densities are weighted averages, as modeled by Miller 2008, for non-forest, recent harvest areas, young forest, and older forest for a set of watersheds comprising each province. Landslide delivery is to stream channels <20% gradient. Relative landslide densities do not have the same starting point on Figures 4-151, 4-152, and 4-153, because the harvest land base varies from 620,822 acres under the No Action Alternative to 1,434,248 acres under Alternative 3.

The variation in effects on relative landslide density among the alternatives within the harvest land base indicates that the specific location of management actions in relation to landslide-prone ground would have more influence on relative landslide density than the land use allocations or management direction. For example, Alternatives 1 and 2 would have similar management direction within the harvest land base, yet would have different effects on relative landslide density within the harvest land base. Under Alternative 1 and the No Action Alternative, the area allocated to the harvest land base would be similar, yet would have different effects on relative landslide density within the harvest land base, especially in the Coast Range Province.

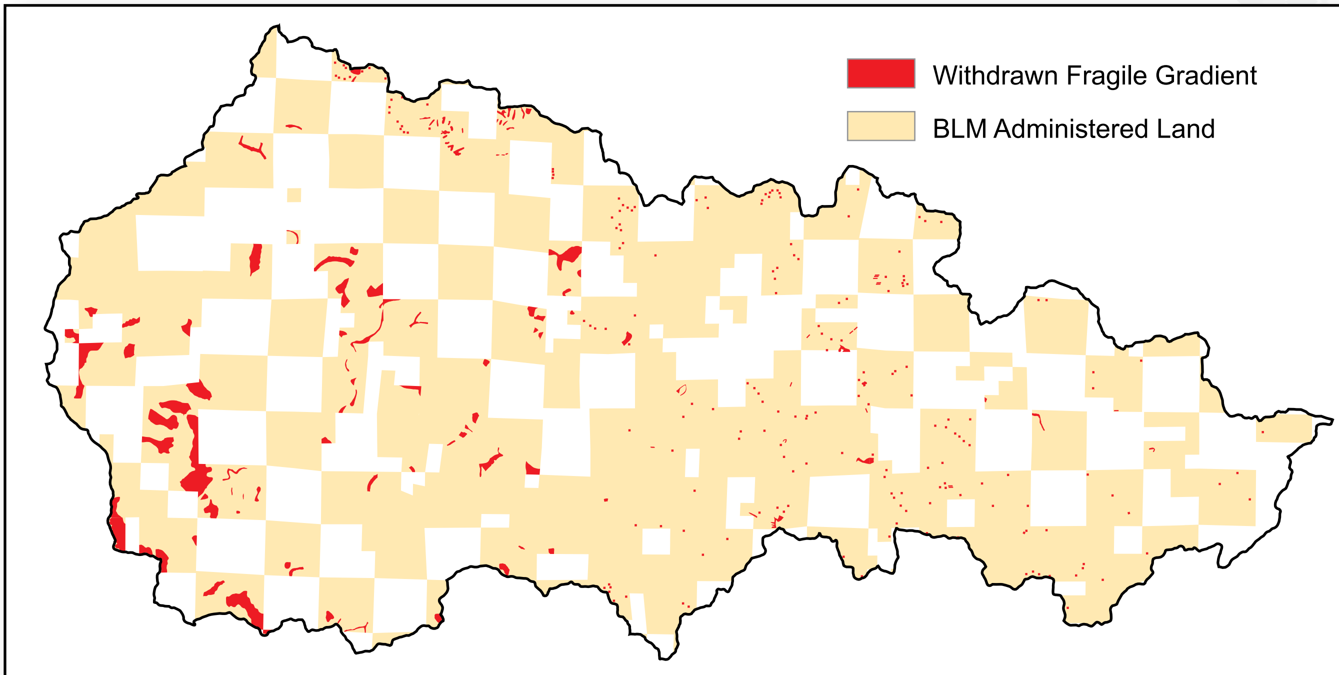
This analysis of relative landslide density within the harvest land base does not consider the effect of future implementation of Best Management Practices and future withdrawal of landslide-prone lands from the harvest land base. For example, when areas of susceptible fragile ground are identified during timber harvest planning and field work, the location or manner of harvest would be modified, or the susceptible fragile lands would be withdrawn when determined unsuitable for management activities associated with timber production. All alternatives would include Best Management Practices for timber harvest and road construction, which include the avoidance of landslide-prone steep sideslopes and susceptible headwalls; end hauling of waste material on steep slopes; and other measures designed to avoid landslides. The specific effects of implementation of Best Management Practices and withdrawal of landslide-prone lands would depend on site-specific and project-specific factors that cannot be quantitatively evaluated at this scale of analysis and would be considered in planning and design of implementation-level actions. However, implementation of Best Management Practices and withdrawal of landslide-prone lands would have the general effect of reducing the relative landslide density of all alternatives to a level substantially similar to the level of the No Harvest reference analysis.

Even without considering the effect of future implementation of Best Management Practices and future withdrawal of landslide-prone ground, the relative landslide density would be lower in the harvest land base than in the nonharvest land base under all alternatives. This is because there is proportionally more area of stable lands in the harvest land base compared to the non-harvest land base as a result of the withdrawal of landslide-prone land from the harvest land under all alternatives. The comparison of *Figures 4-151* and *4-148* together and, *4-152* and *4-149,* and *4-153* and *4-150*, shows that the relative landslide density by province under Alternatives 2 and 3 and the PRMP would be 15-30% lower in the harvest land base at any point in time than across all land use allocations. Under Alternative 1 and the No Action Alternative, there would be 3-10% lower relative landslide density in the harvest land base than across all land use allocations.

The lower relative landslide density within the harvest land base indicates that the effect of withdrawing unsuitable lands has effectively reduced the relative landslide density more than future timber harvest activities would increase the relative landslide density under any of the alternatives. The past practice of withdrawing unsuitable landslide-prone lands as part of Timber Productivity Capability Classification would continue under all alternatives. Approximately 90,000 acres of fragile BLM-administered lands within the planning area (3.5% of the BLM-administered lands) have been withdrawn from forest management (see *Chapter 3 – Water*; *Appendix R – Vegetation Modeling*). The Timber Productivity Capability Classification includes consideration of very steep slopes, skeletal soils and rock outcrops, waterlogged soils, and other fragile landforms when determining if it would be appropriate to withdraw lands from the harvest land base due to susceptibility to mass wasting. See *Figure 4-154 (Timber productivity capability classification withdrawals within the Upper Smith River representative watershed).*

Although it is not possible at this scale of analysis to reasonably quantify the amount of sediment that would be delivered from landslides to streams, the amount over time would be substantially similar to the amount that the No Harvest reference analysis indicates would occur naturally in the absence of active management. Even without including the effect of future implementation of Best Management Practices and future withdrawal of landslide-prone lands from the harvest land base, the relative landslide density under the PRMP, Alternative 2, and Alternative 3 would be substantially similar to the No Harvest reference analysis. Implementation of Best Management Practices and future withdrawal of landslide-prone lands from the

Figure 4-154. Timber Productivity Capability Classification Withdrawals Within The Upper Smith River Representative Watershed



harvest land base would further reduce the relative landslide density under the No Action Alternative and Alternative 1 towards a relative landslide density substantially similar to the other alternatives and the No Harvest reference analysis. Therefore, sediment inputs to streams from harvest-related landslides over time under all alternatives would be substantially similar to the amount that would occur naturally in the absence of active management on BLM-administered lands.

Water Quality Impacts from Prescribed Burning, Off-highway Vehicle Use, Grazing and Other Activities

In addition to the effects of timber harvest and road construction on water quality described above, other management actions (including prescribed burning, off-highway vehicle use, and grazing) have the potential to affect water quality.

Prescribed burning would be used under all alternatives for slash treatment (see *Chapter 4 – Fire and Fuel*) and would have the potential to create soil erosion and sediment delivery to streams. There are a variety of slash reduction practices that may be utilized depending on harvest type, stand and fuel reduction objectives, and climatic and fuel loading differences, from the northern to southern end of the planning area. The specific effects of prescribed burning on sediment delivery would depend on site-specific and project-specific factors that cannot be quantitatively evaluated at this scale of analysis and would be considered in planning and design of implementation-level actions. Nevertheless, broadcast burning for site preparation after regeneration harvesting would involve higher fuel loadings, longer duration, and higher intensity fires compared to other types of prescribed burning, and therefore would have more potential for effects on sediment delivery.

It is projected that 50% of the regeneration harvest units from the first decade levels of regeneration harvest would be broadcast burned (see *Chapter 4 – Fire and Fuels*) on an annual basis. At this rate, there would be approximately 3,000 acres broadcast burned under the No Action Alternative; 4,500 acres under Alternative 1; 7,200 under Alternative 2; 200 acres under Alternative 3; and 3,800 acres under the PRMP. Soil erosion after broadcast burning can be expected to vary from 0.4 to 2.6 tons per acre per year on a burned forest floor until vegetation is established (Megahan and Molitor 1975), and this is not appreciably different than the range of erosion in an undisturbed forest of 0.01 to 2.47 tons per acre per year (USDA USFS 2005). Under all alternatives, Best Management Practices that would be applied to the design of prescribed burning projects (see *Appendix I - Water*) to maintain or improve water quality would limit the production of sediment. Examples of Best Management Practices include planning low severity fires under optimum fuel moisture content (spring-like conditions) to achieve sufficient fuels reduction but limit bare mineral soil. Maintenance of patchiness of residual ground cover after broadcast burning as forest floor litter, vegetation, rocks and unburned fuels would intercept and contain onsite soil loss of most particles within the broadcast burn area (USDA USFS 2005). Eroded soil material that would move downslope from broadcast burned areas would be intercepted and filtered by the Riparian Management Areas (or riparian reserves) between regeneration harvest units and stream channels under all alternatives.

As explained above, Riparian Management Areas (or riparian reserves) wider than 33 feet would generally be effective at intercepting and filtering sediment and precluding delivery to streams. The No Action Alternative, Alternative 1, and the PRMP include Riparian Management Areas (or riparian reserves) that are greater than 33 feet wide on all streams. Therefore, under the No Action Alternative, Alternative 1, and the PRMP, any sediment produced from broadcast burning would be intercepted and filtered by the Riparian Management Area (or riparian reserve) and would not result in sediment delivery to streams. Under Alternatives 2 and 3, Riparian Management Areas would wider than 33 feet on most streams, but 25 feet wide along intermittent stream channels that are not debris-flow prone under Alternative 2 and along all intermittent stream channels under Alternative 3. This width would be most, but not all of the distance indicated by Rashin et al. (2006) as being effective to intercept and filter sediment. It is possible that broadcast burning under Alternatives 2 and 3 near intermittent streams could result in some fine sediment delivery to streams, but only where application of Best Management Practices would not completely prevent sediment production and delivery. Whether specific broadcast burning projects under Alternatives 2 and 3 near intermittent streams would result in fine sediment delivery, and if so, how much fine sediment delivery, would depend on site-specific stream and riparian conditions and the specific design of broadcast burning and Best Management Practices, which cannot be analyzed more precisely at this scale of analysis. Nevertheless, any sediment delivery to streams from broadcast burning under Alternatives 2 and 3 would be temporary and decrease to natural levels in on to two growing seasons (USDA USFS 2005), highly localized, and limited in magnitude.

Any sediment delivery from broadcast burning under Alternatives 2 and 3 would be highly localized because of the limited extent of broadcast burning near the riparian areas of intermittent streams. Alternative 3 would have less than 5 acres of broadcast burned area adjacent to the riparian areas of intermittent stream channels each year along less than 1 mile of intermittent stream channel. Alternative 2 would involve approximately 200 acres per year of broadcast burning along the riparian areas of 33 miles on non-debris-flow intermittent stream channels, which is less than 0.2% of the total BLM intermittent stream miles. Any sediment delivery from broadcast burning under Alternatives 2 and 3 would be limited in magnitude because of the effect of Best Management Practices to limit fire severity and sediment production; the interception of eroded sediment within the broadcast burn area; and the interception of remaining eroded sediments that move downslope within the Riparian Management Area. Under Alternative 3, the Riparian Management Area would be undisturbed. Under Alternative 2, the Riparian Management Area includes a 25-foot streambank zone that would be retained including forbs, shrubs, noncommercial trees and 12 conifers per acre (refer to *Table-2-53* in *Chapter 2*). Even though there would be less conifer trees retained than other Riparian Management Area allocations, the understory vegetation and surface litter would be as effective as an unharvested Riparian Management Area in intercepting and filtering sediment.

Prescribed burning would be used under all alternatives within Riparian Management Areas (or riparian reserves) to reduce fuel hazard loadings or for restoration purposes and would have the potential to create soil erosion and sediment delivery to streams. Prescribed burning within Riparian Management Areas (or Riparian Reserves) would likely be limited to the Medford District and Klamath Falls Resource Area. Whether specific prescribed burning projects for fuel treatment or restoration would result in fine sediment delivery, and if so, how much fine sediment delivery, would depend on site-specific stream and riparian conditions and the specific design of prescribed burning and Best Management Practices, which cannot be analyzed more precisely at this scale of analysis. Due to rapid establishment of grasses, forbs, and shrubs, any fine sediment delivery would be temporary (generally less than 1-2 years), and the deliverable amount of sediment would depend on the residual vegetation, organic material and duff, soil organic matter, site roughness, soil type, and slope steepness. Best Management Practices for soil and water protection and meeting water quality standards would require fuel prescriptions to be low-intensity, short-duration burns and only where fuel loads are light (up to 12 tons per acre) under favorable moisture and weather conditions that would reduce the potential for sediment delivery. Residual vegetation, unburned debris, and surface duff would be retained with an expectation that no more than 5% of bare soil would be exposed where soil material could be detached. This residual groundcover would effectively intercept and filter most or all fine sediment before it could be delivered to stream channels. Additional Best Management Practices include limiting of fire ignition within Riparian Management Areas and distributing treatment areas (see *Appendix I - Water*), which would reduce the potential magnitude of any sediment delivery to stream channels.

Off-highway vehicle use under all alternatives would have the potential to result in contaminant and sediment delivery to streams. These potential effects on water quality would be reduced by the designation of limited or closed areas and the application of Best Management Practices. Under the action alternatives, nearly all BLM-administered lands would be designated as "limited to designated roads and trails" for off-highway vehicle use. Under the No Action Alternative, there would be 300,000 acres of off-highway vehicle designated as open, and 950,000 acres designated as "limited to existing roads and trails." Under the PRMP, there would be no acres designated as "open," while under Alternatives 1, 2, and 3 there would be 77 acres designated as "open." There would be no effect on water quality in the 77-acre "open" area (Heceta Dunes) under Alternatives 1, 2 and 3, because this area is wind blown sand dunes that do not drain to stream channels. There would be an increase of 58% as "limited to designated roads and trails" for off-highway vehicle use under the action alternatives compared to the No Action Alternative.

Limiting off-highway vehicle use to designated roads and trails compared to off highway use in open areas would prevent oil and grease and other contaminants from entering waterbodies and also prevent wheel-track surface disturbance and consequent gullying in erodible soils and sediment delivery to waterbodies. Erosion and sedimentation of streams would be reduced by "limiting off-highway vehicles to *designated* roads and trails" compared to "limited to *existing* roads and trails," because roads with surfaces that may erode from off-highway vehicle use or roads where off-highway vehicle use cannot reasonably avoid crossing through stream channels would not be designated. Therefore, the potential for water quality effects from off-highway vehicle use would be lower under all of the action alternatives than under the No Action Alternative. In addition, 17 Best Management Practices are identified that address the maintenance or improvement of water quality as related to off-highway vehicle use, including measures that would avoid creation of contaminants or sediment within riparian areas and measures that would reduce the potential for delivery of contaminants or sediment to stream channels (See *Appendix I - Water*).

The grazing of cattle along rangeland streams would contribute contaminants to water (fine sediment and bacteria) and elevate stream temperatures. This analysis assumes that the Standards for Rangeland Health (1997), particularly standard II (riparian area function) and standard IV (water quality) would be achieved at the earliest possible date, or when permits or leases are renewed. Under all alternatives, the general guidelines for grazing management and Best Management Practices for water quality would be expected to meet the proper functioning condition of streams and water quality standards in the long term. These measures would include:

- Providing adequate cover and plant community structure to promote stream bank stability, debris and fine sediment capture, and floodwater energy dissipation in riparian areas.

- Maintaining or restoring plant communities to promote photosynthesis throughout the growing season.
- Completing range improvements including riparian pasture fencing, development of off-stream watering, and the relocation of animal holding facilities away from riparian areas.

Placement of culverts and instream structures (e.g., for fish habitat restoration projects) could result in an increase in turbidity and potential downstream sediment delivery. Under all alternatives, culvert placements and other instream activities would cause short-term, localized increases in turbidity (less than eight hours in duration and less than 300 feet from the culvert replacement or instream activity). The potential increase in turbidity would be the same under every alternative, and effects on water quality would be limited or avoided by the application of Best Management Practices, such as diverting water around a site, use of containment and filtering techniques (e.g., silt curtains), and limiting mechanized equipment along streambanks, which would be applied to meet water quality standards. Site-specific and highly localized effects on sediment delivery from placement of culverts and instream structures would depend on site-specific stream conditions and the specific project design, which cannot be analyzed more precisely at this scale of analysis. Site-specific effects of placement of culverts and instream structures on sediment delivery would be considered during the planning of implementation-level actions.

Source Water Watersheds for Public Drinking Water

There are 80 source water watersheds for public drinking water within the planning area. The potential contaminant sources that would impact the surface water have been identified as part of the Oregon Department of Environmental Quality Source Water Assessments (see *Chapter 3 - Water*). Potential sources of water quality impairment under all alternatives would include: timber harvest, construction, maintenance, and use of roads and stream crossings, river recreation, construction and maintenance of transmission lines, grazing, prescribed burning, off-highway vehicle use, and quarry operations. Under all alternatives, Riparian Management Areas (or riparian reserves) would limit disturbance near streams and waterbodies and would intercept and filter potential contaminants. In addition, the application of Best Management Practices during management activities under all alternatives would limit or avoid the delivery of contaminants to streams and waterbodies (see *Appendix I - Water*). Under all alternatives, forest management activities would occur in source water watersheds for public drinking water within the 1,000-foot sensitive zones identified by the Oregon Department of Environmental Quality (*see Chapter 3-Water*). All alternatives would have little or no effect on the parameters of concern from forest operations, including increases in stream temperature and sediment delivery, in source water watersheds for public drinking water as described above in this section.

Management activities on BLM-administered lands would maintain stream shade under all alternatives and, therefore, would not contribute to an increase in stream temperatures. The incremental increase in fine sediment delivery to stream channels from new road construction would be less than 1% above current conditions under all alternatives. Relative landslide density across the planning area would decline from the current condition under all alternatives, and sediment inputs to streams from harvest-related landslides over time under all alternatives would be substantially similar to the amount that would occur naturally in the absence of active management on BLM-administered lands. Other potential sources of sediment would not result in delivery of fine sediment to streams that would be measurable at this scale of analysis, because of the interception and filtration of sediments by the Riparian Management Areas (or riparian reserves) and the effect of the application of Best Management Practices. Therefore, BLM activities under all alternatives would have a low risk for changing the suitability of these waters for public source waters.