EDDY GULCH LATE-SUCCESSIONAL RESERVE FUELS / HABITAT PROTECTION PROJECT

GEOLOGY REPORT

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Supporting Documents in the Project Record

The project record contains the geologist's field notes and the unit-by-unit descriptions of the proposed treatment units and new temporary roads.

Geology Report

1.1 Introduction

The role of the geologist for the Eddy Gulch Late-Successional Reserve Fuels / Habitat Protection Project (Eddy Gulch LSR Project) is to (1) describe relevant aspects of the project's geologic setting, (2) identify significant geologic hazards and resources potentially affected, and (3) participate in the development and evaluation of alternatives relative to applicable laws and the Standards and Guidelines contained in the Klamath National Forest Land and Resource Management Plant (Klamath LRMP).

1.1.1 Project Location

The Eddy Gulch LSR Project Assessment Area is located on the Salmon River and Scott River Ranger Districts, Klamath National Forest, in southwestern Siskiyou County. The LSR is located mostly west of Etna Summit, south of North Russian Creek and the town of Sawyers Bar, east of Forks of Salmon, and north of Cecilville. The LSR is about 61,900 acres in size, making it one of the largest LSRs on the Klamath National Forest. The LSR encompasses much of the area between the North and South Forks of the Salmon River, as well as headwaters of Etna Creek. Elevations range from 1,100 feet to about 8,000 feet. The terrain is generally steep and dissected by sharp ridges and streams. There are a few private inholdings in the LSR and along the main Salmon River and other stream corridors adjacent to the LSR.

The legal description for the Eddy Gulch LSR includes the following (all Mount Diablo Meridian):

T38N, R11W, Sections 2-5, 8-10, and 17-19;
T38N, R12W, Sections 1-3, 9-16, and 22-24;
T39N, R10W, Sections 2-10, 15-21, and 29-31;
T39N, R11W, Sections 1-18, 20-29, and 32-36;
T39N, R12W, Sections 11-14, 23-25, and 36;
T40N, R10W, Sections 3-5, 8-11, and 13-35;
T40N, R11W, Sections 24-27 and 34-36;
T41N, R10W, Sections 2-5, 8-17, 20-24, 26-29, and 31-34; and
T42N, R10W, Sections 28-29 and 32-35

1.1.2 Terms

Eddy Gulch LSR — the entire 61,900-acre LSR.

Assessment Area — the 37,239-acre portion of the Eddy Gulch LSR west of Etna Summit where various treatments are proposed. All roadless areas that occur in the LSR were excluded from planning efforts and are therefore not part of the Assessment Area.

Treatment Unit — the acres proposed for some type of treatment under a particular alternative.

Analysis Area — the area around treatment units considered in the effects analysis (the analysis area may be larger than the LSR Assessment Area and varies by resource). Section 1.5.2 describes the analysis area for soils.

1.2 Summary of the Alternatives

Chapter 2 in the environmental impact statement (EIS) for the Eddy Gulch LSR Project presents more information about the three alternatives, and Appendix A in the EIS contains project maps.

1.2.1 Alternative A: No Action

The no-action alternative is described as continuation of the current level of management and public use—this includes road maintenance, dispersed recreation (hunting, fishing, camping, and hiking), mining, watershed restoration projects, and the modeled wildfire. The time frame for analysis is considered to be 20 years. Given the fuel hazard in the Eddy Gulch LSR and current predictions of climate change, it is assumed at least one wildfire will escape initial attack during the 20-year period and burn under 90th percentile weather conditions (defined as 10 percent of the days in the historical weather database that had lower fuel moisture and higher wind speeds compared to the rest of the days). An analysis of a wildfire for three days that escaped initial attack in the Eddy Gulch LSR Project Assessment Area indicates that fire would burn 7,200 acres. Of those 7,200 acres, 1,355 acres (19 percent) would be surface fire; 5,065 acres (70 percent) would be a passive crown fire; and 780 acres (11 percent) would be an active crown fire.

1.2.2 Alternative B: Proposed Action

The Klamath National Forest proposes 25,969 acres of treatments to protect late-successional habitat and communities. Three primary treatment types were identified in the Assessment Area: Fuel Reduction Zones (FRZs), Prescribed Burn Units (Rx Units), and Roadside (RS) treatments along emergency access routes, which are described below.

- **FRZs**—strategically located on ridgetops to increase resistance to the spread of wildfires. The FRZs would be wide enough to capture most short-range spot fires, and ground, ladder, and crown fuels would be reduced so as to change crown fires to surface fires within the treated areas. The FRZs would provide safe locations for fire-suppression personnel to take fire-suppression actions during 90th percentile weather conditions, and they serve as anchor points for additional landscape-level fuel treatments, such as underburning.
  - ***Proposed Action*.** Construct 16 FRZs totaling 8,291 acres to increase resistance to wildfires. The 8,291 acres includes 931 acres in 42 M Units (thinning units) and 7,383 acres in fuel reduction areas (outside the M Units) to reduce ground and ladder fuels.
- **Rx Units**—a series of landscape-level treatments (ranging from 250 to 4,300 acres in size) designed to increase resilience to wildfires by reducing ground and ladder fuels. Most of these treatments would occur on south-facing aspects where fuels dry faster, and treatments would support the role of the FRZs.

  - ***Proposed Action*. *Implement*** 17,524 acres of Rx Units to increase resiliency to wildfires.

- **RS treatments**—along 60 miles of emergency access routes identified in the Salmon River Community Wildfire Protection Plan (CWPP) (SRFSC 2007) and designed to facilitate emergency access for residents to evacuate and for suppression forces to safely enter the LSR in the event of a wildfire.

  - ***Proposed Action*.** Treat 44 miles of emergency access routes in FRZs and Rx Units (treatments would be similar to the FRZ or Rx Unit the route passes through) and 16 miles (with 154 acres of treatments) of RS treatments outside of FRZs and Rx Units—a total of 60 miles of RS treatments along emergency access routes.

Proposed Temporary Roads and Landings

The construction of new temporary roads and the use of former logging access routes are proposed to access treatment units.

- Approximately 1.03 miles (5,433 feet) of new temporary roads would be used to access all or portions of seven M Units. All of these temporary roads would be closed (ripped and mulched, as needed) following thinning.
- Approximately 0.98 mile (5,177 feet) of former logging access routes would be re-opened (vegetation removed and bladed) to access all or portions of five M Units. These routes would be water-barred and closed immediately after thinning is completed.
- Five short spurs, each less than 100 feet long, would be bladed for tractor or cable yarding operations in two units.
- Existing landings will be used.

1.2.3 Alternative C: No New Temporary Roads Constructed

Alternative C responds to public concerns regarding the environmental and economic effects of constructing new temporary roads. Alternative C is similar to the Proposed Action but approximately 1.03 miles (5,443 feet) of new temporary roads identified in the Proposed Action would not be constructed. As a result, no fuels treatments would occur in portions of seven M Units. This reduces the total acres of treatments in M Units from 931 acres under Alternative B to 832 acres in Alternative C. Fuels treatments could not be carried out in those M Units because of excessive treatment costs, high existing dead crown fuel loadings, and potential heat damage to the overstory if these untreated units were prescribed burned.

Under Alternative C, the FRZs would continue to total 8,291 acres; however, 99 acres in M Units would remain untreated. The total number of acres treated by tractor yarding would remain at 361 acres; however, the acres of cable yarding would be reduced from 570 acres under Alternative B to 471 acres under Alternative C. Reducing acres of M Units treated would also reduce the number of acres treated in two Rx Units because excessive fuels remaining in M Units would preclude safely burning portions of the two Rx Units. Six-foot-wide control lines would be constructed around the perimeter of those untreated areas to keep prescribed burns out of those portions of Rx Units. There would be no changes in the miles of emergency access routes treated, transportation plan, or resource protection measures.

1.2.4 Summary of the Action Alternatives

Table 1 summarizes proposed activities under Alternatives B and C.

Table 1. Summary of treatments under the action alternatives.

Action Alternative	M Units in FRZs					Fuel Reduction Areas in FRZs		Rx Units (acres)
	Cable (acres)	Tractor (acres)	Number of Existing Landings	New Temp Road (miles)	Former Logging Access Route (miles)	Mastication (acres)	Underburn (acres)	
B	570	361	73	1.03	0.98	3,184	5,107	17,524
C	471	361	69	0	0.98	3,184	5,107	16,702

1.3 Significant Issues

Public and agency comments received during collaboration and scoping efforts did not identify any significant issues related to geology. The only significant issue was in regard to construction of new temporary roads to access some of the treatment units. Alternative C was developed in response to public concerns regarding the environmental and economic impacts of constructing new temporary roads.

1.4 Regulatory Framework

Guidance for the management of geologic resources is primarily embodied in the Klamath National Forest Land and Resource Management Plan (Klamath LRMP) (USFS 1995a), which provides for the inclusion of geologically unstable lands into Riparian Reserves. The Klamath LRMP Standards and Guidelines for Riparian Reserves call for precautionary management to prevent destabilization of sensitive geologic areas.

To the extent that landslides can be an overwhelming source of sediment to streams, management of geologically unstable areas can be viewed as indirectly covered under the North Coast Basin Water Quality Control Plan and state and federal Water Quality Control laws.

More specific guidance on management of geologic resources is found in Forest Service Manual (FSM) Section 2880 (USFS 2008) and relevant sections of Forest Service Handbook (FSH) 2509.22 Soil and Water Conservation Handbook (USFS 1990).

1.5 Methodology

The geologic assessment followed guidance for project-level investigations given in Methods for Mapping Unstable Lands. This is an internal guidance document prepared by Klamath National Forest geologists.

1.5.1 Analysis Methods and Assumptions

The primary steps for this geologic analysis involved

1. review of existing data, including Geo13 map layer that exists on the Klamath National Forest's Geographic Information System (GIS);

2. review of the geology sections in the three watershed analyses (USFS 1994b; USFS 1995b; USFS 1997) that cover the Assessment Area;

3. review of published geologic maps to understand the distribution of rock types;

4. examination of air photo coverage for potential landslides or unstable features not already mapped; and

5. field review of proposed treatment units with the purpose of identifying site features that might indicate instability.

These features include hummocky or broken slope topography (scarp-bench-toe sequences), mid-slope or near-channel deposits of colluvium, area-wide patterns of springs and seeps, jack-strawed trees, and currently active scarps or ground fracture. Debris slide and debris torrent events will often be marked by drainages scoured to widths far greater than the active channel, with clear and abrupt changes in type or age class of vegetation. Field assessment also requires an understanding of the structural properties of various rock types and their relative potentials for producing unstable slopes.

Where confirmed or suspected unstable slopes were encountered but not already mapped on Geo13, their locations were noted, the feature was reviewed on air photos, and its estimated boundaries drawn on a field map.

Information on bedrock and geomorphic features is taken from the Klamath National Forest GIS coverages. Landslide sediment model coefficients were taken from studies in the Salmon River watershed (USFS 1994b).

This investigation focused on slope stability issues related to project activities. Refer to the Aquatic Resources Report for information on water quality and the Soils Report for information on soil productivity. The geologic assessment involved about 20 field days and 15 office days. With only a few exceptions, the project geologist, hydrologist, and soil scientist conducted field reviews and evaluated all proposed thinning units, new temporary road locations, former logging access routes, and existing landings. Findings from the field reviews are documented in the project geology notes and unit descriptions (contained in the project record) and in the Water Resource Report. The unit descriptions include recommendations for changes to Riparian Reserve boundaries and any slope instability features that were not previously mapped. The Klamath National Forest geomorphology and bedrock layers were updated as part of this project.

1.5.1.1 Discussion

Riparian Reserves. The Riparian Reserves encompass a wide variety of land types, ranging from streamside areas and wetlands to relatively dry landslide-prone hillslopes that have the potential to deliver sediment to streams. As a result, geomorphic and ecologic processes in these diverse land types are highly variable. Delineation and protection of Riparian Reserves is a key part of the Aquatic Conservation Strategy (ACS) of the Northwest Forest Plan. The Riparian Reserve consists of lands where riparian-dependent resources receive primary emphasis and where special Klamath LRMP Standards and Guidelines apply. They include those portions of a watershed required for maintaining hydrologic, geomorphic, and ecologic processes that directly affect standing and flowing water bodies such as lakes and ponds, wetlands, streams, stream processes, and fish habitats. They also include unstable lands (active landslides, inner gorge, toe zones of dormant landslides, and weathered and dissected granitic terrain).

The Klamath LRMP defines standard slope distance for Riparian Reserves as two site-potential tree heights or 300 feet for anadromous and resident fish-bearing streams (whichever is greater) and one site-potential tree height or 150 feet for nonfish-bearing streams (whichever is greater). This project defines one site-potential tree height as 170 feet on each side of a qualifying stream channel. Therefore, the Riparian Reserve width is 340 feet for fish-bearing streams and 170 feet on each side of an active stream channel for nonfish-bearing streams. Refer to Appendix A for additional information on Riparian Reserves.

Vegetation Management in Riparian Reserves. Standards and Guidelines in the Klamath LRMP direct that vegetation in landslide-prone Riparian Reserves be managed to enhance slope stability and promote aquatic values. The overriding goal for vegetation management in Riparian Reserves is to maintain hydrologic, geomorphic, and ecologic processes that directly affect standing and flowing water bodies such as lakes and ponds, wetlands, streams, stream processes, and fish habitats. This goal can be achieved by meeting the following objectives:

- *Species*—Maintain a variety of native, site-adapted species on Riparian Reserves, which are appropriate to the site. Riparian Reserves along streams or in wetlands may require water loving species such as willow and alder, whereas dryer hillslope Riparian Reserves, such as dissected granitic terrain (particularly on south aspects) or some toe zones of deep seated landslides, may require dry land species such as pine and live oak. Both understory and overstory species should be maintained.

- *Age of Vegetation*—Maintain mixed-age vegetation, with a significant proportion in the mature stage.

- *Vigor of Vegetation*—Manage for healthy, vigorous vegetation.

- *Vegetation Densities*—On landslide-prone Riparian Reserves, maintain plant densities that will maximize root support and evapotranspiration and avoid rapid reductions in vegetation density. In most cases, vegetation management should never reduce density to less than 50 percent crown closure.

- *Vegetative Succession*—Avoid or prevent situations that could result in a rapid vegetation type conversion, such as through rapid mortality in a conifer stand. Maintain a continuous vegetative cover through time.

- *Fire Susceptibility*—Avoid or prevent situations where high fuel loading renders Riparian Reserves extremely susceptible to high-severity fire. Similarly, avoid high-density vegetation with a well-developed fuel ladder.

- *Root Characteristics*—On landslide prone Riparian Reserves, manage for native, site-adapted species with deep, laterally extensive and strong root systems. Desirable species include all conifers and hardwoods, as well as brush.

- *Evapotranspiration Characteristics*—On landslide-prone Riparian Reserves, manage for native, site-adapted species that maximize water removal from the soil. On deep-seated landslides, species capable of withdrawing water from greater depths are desirable. Generally, species with large crowns capable of intercepting precipitation and facilitating evaporation are desirable.

- *Ground Disturbance Associated With Yarding*—Avoid all ground-disturbing activities that could alter slope hydrology (concentration of water) and increase landslide risk.

Managing toward these objectives requires a balance between the short-term adverse effects of stand thinning and the short- and long-term beneficial effects of reduced fire hazard and longer-term benefits associated with improved health and vigor.

Eddy Gulch LSR Project Proposed Activities in Riparian Reserves. Small trees would be removed on approximately 6,578 acres of Riparian Reserves throughout the Assessment Area. A masticator would be used on slopes less than 45 percent and within 0.25 mile of a road on 875 acres of FRZs to remove trees less than 10 inches diameter at breast height (dbh). Hand thinning and pile burning would be used on 483 acres of slopes greater than 45 percent in FRZs, and low-intensity backing fires would be used on 5,107 acres in Rx Units to remove trees up to 6 inches dbh. The masticator would not exceed more than 6 pounds per square inch ground pressure. No treatments with mechanical equipment would occur within 30 feet of ephemeral, intermittent, or perennial streams. Equipment may cross dry ephemeral or intermittent streams in designated locations.

1.5.1.2 Wildfire Effects Modeling

The effect of wildfire on slope stability is a function of the spatial interaction of high-intensity fire and latently unstable slopes. This complicates the analysis of effects because, although the fire's probability of occurrence is reasonably high, where the fire occurs is a function of the point of ignition, an assumption used as input to the fire model. To assess the effect on slope stability of a predicted wildfire at the watershed scale requires some assumptions about where high-intensity fire is likely to occur. In particular, the Klamath National Forest's cumulative watershed effects (CWE) model was used to look at risk ratios related to slope stability. The structure of the model requires spatially specific information on soil-disturbing actions or processes to allocate disturbance to specific watersheds. The CWE model results are in Appendix B of this report."

Three separate wildfires, using three different ignition points, were modeled using FLAMMAP. For most analyses, these three scenarios were averaged to produce a non-spatially specific estimate of the potential magnitude and severity of a probable wildfire. One of those modeled wildfires, one that initiates at the Shadow Creek Campground and burns mostly, but not entirely, within the Shadow

Creek watershed, was selected for input to the CWE model. This discussion is presented because conclusions drawn from the CWE output must be tempered by the following considerations: (1) the selection of Shadow Creek represents a kind of worst-case scenario because within the watershed are relatively large acreages of past regeneration harvest, and the largest proportion of mechanical treatments under the Proposed Action when compared with other 7th-field watersheds within the analysis area, (2) errors of estimation are usually compounded when one model's output is used as input to another. The bottom line is that GEO risk ratios reported below for wildfire effects under Alternative A should be interpreted as boundary conditions—a statement of the reasonable outer limit of fire effects. Should an actual fire of similar magnitude and severity occur across multiple watersheds, or across less sensitive lands, then effects would be far less.

1.5.2 Scope of the Analysis

Analysis Area. The analysis area was defined by the project's Assessment Area boundary, although areas outside the boundary were examined on air photos to better understand patterns in the occurrence of unstable slopes in the area. Field review was confined to the immediate vicinity of project treatment units.

Analysis Period. The timeframe for the effects analysis is 0–3 years for short-term effects and up to 10 years for long-term effects on geology.

1.5.3 Reasonably Foreseeable Future Projects in the Vicinity of the Eddy Gulch LSR Project

The Klamath National Forest Schedule of Proposed Actions was reviewed to identify current and reasonably foreseeable projects on the Salmon River and Scott River Ranger Districts that should be included in the cumulative effects analysis for the Eddy Gulch LSR Project. Ongoing projects include annual road maintenance, improvements to existing mining claims, hiking, and appropriate responses for fire suppression. Additional future projects include the following:

- Installing telephone and fiber-optic lines through the Ranger District (this involves digging a trench adjacent to roads to bury the lines and installing access points for future maintenance activities).
- North Fork Roads Stormproofing Project (this involves storm proofing 76 miles of road requiring blading, improving road drainage, and protecting riparian and stream systems; decommissioning 36 miles of roads to reduce sediment delivery to streams; and adding 2.4 miles of existing road).
- Construction of a fuelbreak system west of Black Bear Ranch (approximately 700 acres of ridgetop fuel reduction).
- A small amount of projects on private lands have been funded under the Salmon River CWPP. This includes funding to treat 75 acres of fuels on private properties in and around the Eddy Gulch LSR Project Assessment Area in the next 18 months. There may be funding for at least 50 acres in the following 18 months.

1.5.4 Definitions for Terms Used in this Resource Section

The term “unstable slopes” is a generic term used for all classes of slope movement. More specific categories include:

Debris slides, debris flows, and debris torrents — These are rapid shallow-seated slope failures, usually initiated in headwater basins. They often follow the path of existing drainage channels (debris slides can be an exception). Slide debris can travel great distances and often ends up in a receiving channel or valley bottom.

Earthflow or slump / earthflow — These are deep-seated slow movements that often produce one or more scarp-bench-toe slope profile sequence(s). These are often marked by unusually flat areas (benches) on an otherwise steep hillside.

Toe zones — Accumulations of colluvium, usually originating from slump / earthflow features. The downslope face of this material is usually over steepened, often wet, with potential for further movement.

Active landslide — This term is defined in the Klamath LRMP as a landslide feature with evidence of movement within the last 400 years.

Currently active landslide — This term is used by the authors to denote landslide features exhibiting fresh scarps, ground facture, or other evidence the slope movement has occurred very recently or is ongoing.

1.5.5 Intensity of Effects

Negligible. Slope stability and landslide risk would not be affected. There would be no discernable effect on landslide-related sediment or other effects on beneficial uses of water or other aquatic resources.

Minor. There could be a very small and short-term increase in landslide risk. The duration of increased risk is so short that triggering climatic or seismic events would have a very low probability of occurrence. There would be low probability of landslide-related sediment delivery to streams or other effects on beneficial uses of water. Areas of concern would be localized and easily mitigated with resource protection measures.

Moderate. Increased landslide risk is more extensive across the Assessment Area. The duration of effects lengthens, allowing a high probability of triggering climatic or seismic events. Project-related landslide sediment would be detectable at the 7th-field watershed scale but not at 6th-field or larger scales. Effects on beneficial uses or other aquatic resources would be localized and short duration.

Major. Significantly increased landslide risk is common throughout the Assessment Area. Landslide-related sediment would be a significant concern at the 5th-field watershed scale.

1.6 Affected Environment (Existing Conditions)

Much of the information in this section was obtained from the Geologic map of the Weed quadrangle, California (Wagner and Saucedo 1987), supplemented by field survey in July and August 2008. The study area is located in the Klamath Mountains Province, which consists of typically north-south oriented accreted terrains separated by eastward-dipping thrust faults. Two geologic formations (distinct accreted terrains) comprise the vast majority of the Assessment Area. The Western Palezoic and Triassic Belt is a complex of mostly meta-sedimentary argillites and phyllites with interbedded cherts. However, this belt is a complex suite of arc-convergence rocks that also includes metavolcanic rocks, blueschist facies (low-temperature, high-pressure metasediments), slightly metamorphosed volcanic breccias, and small bodies of peridotite in the complex. Within the assessment area, this formation occurs west of Black Bear Summit in the Black Bear Creek / Argus Gulch area. The argillite component of this formation is a relative weak rock, which can pose slope stability risks. This formation also occurs just north of the divide between the North and South Forks in Eddy Gulch and Whites Gulch.

Thrust over this formation is the Stuart Fork Formation, a belt of accreted terrain, typically consisting of low-temperature, high-pressure metamorphism. This formation is also dominated by metasediments: phyllites and schists with varying degrees of structural competence and fracture spacing from hard massive boulder-sized material to intensely sheared and fractured. The contact between the Stuart Fork Formation and the Western Palezoic and Triassic Belt is marked by numerous springs and seeps. The Stuart Fork Formation occurs in upper Crawford Creek, Shadow Creek, and Sixmile Creek. Where highly sheared and weathered, these rocks can also pose significant landslide risk.

Serpentinized peridotite is found in lower Crawford Creek and in small, scattered pockets in the Western Palezoic and Triassic Belt.

Abrams mica schist occurs in a small pocket south of Grouse Point. Hydration of mica minerals during weathering causes expansion and weakening of the rock’s internal structure. This rock type is very weak and can be broken apart by hand. This structural incompetence also poses slope stability problems, but its occurrence is very limited in the Assessment Area.

A small pocket of dioritic rocks occurs in Callahan Gulch. Elsewhere, granodiorite occurs in Upper South Russian Creek, grading to granite in the Russian Peak Wilderness. Deeply weathered rocks of this type form very noncohesive soils (typically silty sand soils) that tend to produce shallow-seated failures such as debris slides and debris torrents when saturated. In 1996 a debris torrent originating in granitic rocks of upper South Russian Creek scoured the channel down to its confluence with the North Fork. The point of origin of this debris torrent was well above the project Assessment Area and near the Russian Peak Wilderness boundary. Only roadside fuel reduction and underburning are proposed in the South Russian Creek watershed, and those are in the lower reaches of the watershed on mostly nongranitic geology.

Landslides are the major geologic hazard in the Assessment Area, and their occurrence is related to the structural competence of the underlying rocks, pore pressures of water in rocks and soil, and triggering mechanisms. Triggering mechanisms are usually one or more of the following: (1) seismic activity, (2) removal of toe-slope buttressing, and (3) saturation by major rainfall / runoff events.

Certain management activities have been shown to adversely affect landslide risk. In shallow, noncohesive materials, loss of rooting strength through vegetation removal can reduce resisting forces, leading to increased rates of debris slide occurrence (Amaranthus et al. 1985; Sidle and Terry 1992). Large tree roots have been shown to attach to fissures in competent bedrock, which provides anchoring strength across a potential plane of failure, in addition to the increase of shear strength within the soil mass (Abe and Iwamoto 1987). These adverse effects are far more common where vegetation removal is nearly total, such as clearcuts or stand-replacing wildfire.

Soil saturation is often a key factor in the initiation of landslides. Loss of vegetative cover reduces withdrawal of soil moisture through evapotranspiration. This can lead to earlier onset of soil moisture recharge in the fall. In clearcuts or other openings where snow accumulation is increased, the combination of these effects can increase the amount of time that soils are at or near saturation, especially during periods of rapid snowmelt (Gray and Megahan 1981). This suggests that a rather unique combination of factors must be present for the "evapotranspiration effect" to be relevant to landslide risk. Experience has shown that near-total vegetation removal is key requirement. Such drastic modifications to forest vegetation are not part of the Proposed Action.

Road building in similar settings has an even greater effect. Deep-seated earthflow features are less affected by rooting strength and more influenced by the presence of soil moisture to levels that create positive pore pressures. This usually occurs through road construction and the channeling of road runoff onto potentially unstable slopes.

Active landslides (active within the last 400 years) are scattered widely throughout the Assessment Area (Appendix C and Appendix D). The largest is approximately 40 acres in size and occurs in the west branch of Shadow Creek. Air photo examination revealed no evidence of current movement and the site is fully vegetated.

Toe zones of old slides represent a landform with high risk for more landslides. Toe-zone landforms are clustered in Argus Gulch and upper Eddy Gulch but are mostly absent elsewhere in the Assessment Area. Mapped toe zones are all in areas proposed for underburning only. No road construction or timber harvest is proposed on toe-zone areas.

Currently, active landslides were encountered in upper Eddy Gulch along the thrust fault contact between the Western Palezoic and Triassic Belt and the Stuart Fork Formation adjacent to the Liberty Mine boundary and within Rx Unit 12. Another recent debris slide event was located just below M Unit 6 along the Grouse Point Fault in Crawford Creek. Another very small (0.10 acre) slump was located along National Forest System (NFS) road 39N20 in lower Shadow Creek.

The Klamath National Forest CWE model includes a component that estimates potential sediment delivery to streams from management-induced landslides. This model estimates sediment delivery to streams from mass wasting. The GEO models methodology was developed by Amaranthus et al. (1985) and USFS (2004) with an empirical base derived by de la Fuente and Haessig (USFS 1994a). Sediment delivery is estimated using a coefficient matrix of geomorphic terrains and vegetative disturbances. The model produces risk ratios in such a manner that a value of 1.0 represents the

Threshold of Concern (TOC). Currently, only two 7th-field watersheds with significant areas in proposed treatment units have GEO risk ratios in a moderately elevated range: Upper North Russian Creek (risk ratio = 0.87) and Eddy Gulch (0.79). Two other 7th-field watersheds have elevated risk ratios (Indian Creek, 0.87 and Kanaka Olsen, 1.53), but those drainages are scheduled for only very minor amounts of underburning that will not affect their risk ratios. A complete discussion of CWE model results is presented in the "Environmental Consequences" section of this report.

Areas With Watershed Concerns (AWWC) were identified in the Watershed Analyses covering the Assessment Area. Black Bear Creek watershed west of the main channel of Black Bear Creek was identified in the Lower South Fork Salmon Watershed Analysis (USFS 1997) as an AWWC in 1995. Substantial recovery has occurred in the intervening years as evidenced by low CWE risk ratios for all components. Field review found few indicators of impaired watershed function. Kanaka-Olsen has a high GEO risk ratio (1.53) but has only 18 acres of FRZ treatment proposed, most of which is underburning. Similarly, Indian Creek, just west of the Black Bear watershed, is a Klamath LRMP-designated AWWC (ERA=1.04) but is scheduled to receive only 109 acres of FRZ treatment along the ridge between Indian and Black Bear watersheds. Eddy Gulch was considered for AWWC status in the North Fork Salmon Watershed Analysis (USFS 1995b), largely on the basis of the extensive road network but was ultimately not given that status based on field review. Eddy Gulch is scheduled for 370 acres of FRZ treatment, 476 acres of underburn only, and 80 acres of thinning. In each of the watersheds discussed, implementation of the Proposed Action results in risk ratios that are lower at the conclusion the project compared to present levels. In the longer timeframe, treatments will likely result in improved watershed condition through thinning and fuel reduction.

Limestone Bluffs Research Natural Area occurs along the South Fork Salmon River between Cecilville and the Matthews Creek campground. The majority of this outcropping occurs south of the river in the St. Claire and French Creek drainages. The nearest project activity is fuel reduction (FRZ) more than 0.25 mile from the Bluffs. There would be no effect on the Research Natural Area or cave resources from implementation of either action alternative; therefore, these areas are not discussed further in this report.

Landslides can adversely affect human life and property, particularly roads and associated infrastructure, and fish habitat. Landslide hazards in the Assessment Area consist of two main types:

- *Shallow Rapid Landslides (Debris Slides)*—Sandy soils that develop on granitic rock are often very prone to debris slides, particularly where bedrock is deeply weathered and dissected. Such bedrock underlies a very small proportion of the Assessment Area. The majority of the Assessment Area is underlain by schist and phyllite of sedimentary origin. The few debris slides that have occurred in the last few decades are concentrated in a headwater basin of Eddy Gulch.

- *Deep, Slow-Moving Landslides (Earthflows and Slumps)*—Ancient slump / earthflow features are common throughout the Assessment Area and have been a major geomorphic factor shaping the landscape. The landslide debris produced by these events form Toe Zones where disrupted drainage patterns, lower internal shear strength, perched water tables, and oversteepened slope facets can increase potential for subsequent debris slides. Toe zones occur throughout the Assessment Area but are most concentrated in Argus Gulch and Eddy Gulch.

Landslide features on the Klamath National Forest are broken down further into 13 sub-categories. Of these, “active landslides,” “toe zones,” and “inner gorge zones” were most common in the Assessment Area. Many areas mapped as “active landslide” actually show no indications that movement has occurred for a century or more.

The types of project activities that could potentially initiate or accelerate landsliding include:

- Construction of new temporary roads (see Appendix C);
- Use of former logging access routes;
- Tractor yarding;
- Vegetation removal associated with thinning activities; and
- Vegetation removal associated with prescribed fire.

Airborne asbestos can be introduced into the air by road construction, reconstruction, or maintenance on roads underlain by ultramafic rock, or the development of rock quarries in ultramafic rock and placement of such aggregate on roads. Ultramafic rock is concentrated in the southwest corner of the Assessment Area. The community of Cecilville is located in this general area but is at least 2 miles from the nearest project activity. Also, see Appendix I for the report titled, “Naturally Occurring Asbestos in Eddy Gulch LSR Project.”

With only minor exceptions at water drafting sites, rock aggregate application is proposed for road surfacing. Commercial sources of aggregate will be used for water drafting sites.

No domestic water wells are known to exist in or near the project boundary. There are numerous springs within the Assessment Area. Seeps and springs are especially common along both sides of the divide between the North and South Forks of the Salmon River, above 5,000 feet in the vicinity of the Eddy Gulch Lookout. Campbell springs is the most prominent of these springs but many others exist in this zone. Effects of this project on the groundwater resource are expected to be negligible, and as a result, it is not addressed further.

1.7 Desired Conditions

The desired condition is that management actions will have no influence on natural background rates of sediment production from landslides; in other words, there will be no management-induced landslides. Landslides (particularly debris slides) that originate in road or landing fill slopes are the easiest to recognize as being management induced. Elsewhere, separating management influences from natural factors are subject to judgment, especially since many years must usually pass before a triggering mechanism sets potentially unstable slopes in motion.

Another aspect of desired condition is that no project activity will produce elevated GEO risk ratios in any 7th-field or larger watershed that causes an “at-risk” or “non-functioning” condition.

1.8 Environmental Consequences

Environmental consequences are assessed and alternatives are compared by the following means:

- *Proposed Actions*—proposed activities are listed and described (Section 1.2 above).
- *Geology Program Goals*—proposed activities are evaluated according to how well they would meet the goals of the Klamath National Forest Geologic Program (Appendix E), as outlined in the Klamath National Forest Sufficiency Standards for Geology (Appendix F).
- *Direct and Indirect Effects*—the direct and indirect effects of project activities are evaluated.
- *CWEs*—the landslide sediment model is used to estimate the volume of landslide sediment likely to be produced as a result of proposed activities.
- *Conclusion*—a short summary describes the overall effects of the alternative.

Geology Program Goals. The five goals of the Klamath National Forest geologic program, as outlined in the Klamath National Forest Sufficiency Standards of 2003 are as follows:

1. Ensure conformance to all elements of the ACS.
2. Protect water quality and quantity to meet state and federal water quality standards, Forest Service policy, and FSM 2880 direction.
3. Protect public health, safety, welfare, and property from geologic hazards on National Forest System lands.
4. Protect geologic resources (minerals, groundwater, geothermal power, rock aggregate, Geologic Special Interest Areas, and caves) from being adversely affected by land management activities.
5. Develop geologic resources (groundwater, rock aggregate, mineral, oil, geothermal, unique geologic areas) in an environmentally and economically sound manner.

Appendix E displays an evaluation of the extent to which the Proposed Action would meet these goals and the rationale for the conclusions reached.

1.8.1 Alternative A: No Action

1.8.1.1 Geology Program Goals

The no-action alternative has a high probability of meeting all of the five geologic goals.

Landslide Risk

Direct and Indirect Effects

Under this alternative, there would be no new soil or vegetation disturbances, and consequently, no direct or associated indirect effects from project-related activities. With no action taken, the existing risk of road-related landsliding would remain the same, and the adverse effects of past harvest and fire would decrease over time as vegetation continues to grow. In the long term, the risk of a large stand-replacing fire would continue to increase. Fire modeling (Appendix B) indicates that the effects of failing to reduce this risk can potentially result in significant increases in landslide-related sediment. Under wildfire conditions, the geologic impacts from high fire severity would be compounded by the impacts resulting from suppression equipment accessing the area and fireline construction under demanding circumstances.

Failing to reduce fuel loads in the Assessment Area would increase the risk of stand-replacing wildfire and the accompanying loss of rooting strength on unstable slopes. This, in turn, would increase the potential for accelerated sediment delivery to streams. A dense network of tree roots can add to the shear strength of potentially unstable slopes. This effect is limited to slopes prone to shallow-seated debris slide-slope failures. Such slopes typically have thin soil profiles and relatively non-cohesive soils. Following stand-replacing wildfire, the root network begins to decay, leading to a condition of minimum shear strength a few years following the fire. The direct effect of this process is the loss of soil productivity at the site of the landslide and sediment delivery to immediately adjacent stream channels because shallow-seated debris slides or debris flows can transport landslide debris and sediment long distances down slope. Such processes can result in profoundly affected sediment transport dynamics, channel stability, and the abundance and quality of aquatic habitat.

Cumulative Effects

Existing cumulative effects are entirely the result of previous disturbances such as road construction, timber harvest, and mining. These are discussed and displayed under Alternative B below. Adverse cumulative effects could result from failure to reduce the risk of stand-replacing wildfire. The CWE analysis of the results of wildfire behavior modeling shows that wildfire under existing fuel conditions clearly has the potential to produce significant adverse cumulative effects. Details on this analysis are included in Appendix B.

Failing to reduce frequency of stand-replacing fires would increase the risk of stand-replacing wildfire, with the accompanying loss of rooting strength, loss of vegetative soil water withdrawal, and creation of hydrophobic soils. Wildfire-related soil disturbance which, when added to that created by past actions, may exceed disturbance thresholds established to prevent long-term adverse changes to rates of landslide initiation. Loss of vegetation from stand-replacing fire, acting through the mechanisms listed above, could alter the balance of forces on slopes already modified by past disturbance. As an example, a latently unstable road fill slope, buttressed by large trees at its lower edge and de-watered by shrubs and small trees growing on it, could be further destabilized by the removal of the vegetation by fire.

GEO Risk Ratios. The GEO risk ratios following a fire would be at or below their current values. Table 2 displays the GEO risk ratios that resulted from including the Shadow Creek modeled fire scenario in the CWE analysis. Caution is urged in interpreting these risk ratios for the no-action alternative, particularly for Shadow Creek, because this represents an upper boundary condition for the severity of effects.

Table 2. CWE model output for the no-action alternative with modeled wildfire scenario.

7th-field Watershed	GEO	
	Pre-fire	Post-fire
Sixmile Creek	0.364	0.388
Gould-East Fork South Fork Salmon River	0.454	0.838
Shadow Creek	0.408	1.067
Gooey-Ketchum Creek	0.497	0.538
Crawford Creek	0.287	0.287
Whites Gulch	0.186	0.188

A marked increase is apparent for Shadow Creek, with the wildfire scenario pushing the GEO risk ratio above the inference point of 1.0. The amount of increase would be large (0.41 to 1.07), but the amount by which the fire exceeds threshold is not great. This suggests that effects from increased potential for landslide-generated sediment are likely to be detectable but not of such extent or severity as to significantly degrade water quality or aquatic habitat.

Overall, cumulative effects on landslide-generated sediment delivery are expected to be minor to moderate, depending on the actual location and severity of wildfire. Were such effects to occur, they would be expected to persist for a decade or more until delivered sediments move through the stream network and landslide scars slowly revegetate.

Conclusion. Landslide potential associated with existing roads would remain unchanged, but that associated with previous timber harvest would continue to decline as revegetation progresses. The no-action alternative, with the included modeled wildfire scenario, is likely to produce minor to moderate effects on rates of landslide initiation, water quality, and aquatic habitat. The exact magnitude of effects is wholly dependent on the spatial pattern of high-intensity fire. Were the entire 7,205 acres of predicted wildfire to occur mostly within one 7th-field watershed, effects would be concentrated within that drainage. Otherwise, effects would be substantially less because the effects would be dispersed across multiple drainages. Recovery of rooting strength and natural soil moisture regimes can take a decade or more in areas of high fire intensity. Areas of lesser fire intensity are likely to recover within a decade.

1.8.2 Alternative B (Proposed Action)

Geology Program Goals

Alternative B has a high probability of meeting all of five geologic objectives at a high level, provided geological resource protection measures are applied.

Landslide Risk

Direct and Indirect Effects

A dense network of tree roots can add to the shear strength of potentially unstable slopes. This effect is limited to slopes prone to shallow-seated debris slide slope failures. Such slopes typically have thin soil profiles and relatively noncohesive soils. Thinning stands can result in a short-term decline in root shear strength as the roots of removed trees begin to decay, leading to a condition of minimum shear strength a few years following a fire. Slope failures can also originate in oversteepened fill slopes of roads and landings where they are situated on intrinsically unstable slopes. The direct effect of this process is the loss of soil productivity at the site of the landslide and sediment delivery to immediately adjacent stream channels.

All fuel reduction treatments and thinning prescriptions leave substantial live vegetation, especially larger trees with deep, extensive root systems. Vegetative treatments are unlikely to significantly reduce the contribution of roots to soil shear strength or lessen soil water withdrawal from evapotranspiration. Proposed road alignments for new temporary roads are in stable, upper slope locations with no stream crossings. For these reasons, project effects from Alternative B are expected to be negligible relative to landslide risk and thus landslide-generated sediment delivery to streams.

Direct and Indirect Effects by Project Activity

Direct and indirect effects associated with project activities are described below. It is assumed that geologic resource protection measures are implemented in all applicable situations. Refer to Appendix G for further information on direct and indirect effects by management activity.

Thinning—931 acres. These activities will result in a very small short-term decrease in root support, but most likely will not cause an increase landslide rates. In the longer term, stand vigor will be increased, and root support re-established.

Tractor Yarding—361 acres. By restricting tractors to slopes less than 35 percent slope, and controlling skid trail locations (avoiding full bench trails), ground disturbance on unstable lands would be avoided, and these activities would not likely increase landslide rates.

Cable Yarding—570 acres. Ground disturbances associated with skyline yarding will be excluded from unstable areas, and as a result, would not increase landslide rates.

Construction of New Temporary Roads—1.03 miles. The new temporary roads (Table 3) would be closed upon project completion. There would be a reduction in root support and local evapotranspiration associated with clearing. All new temporary road alignments were inspected for landslide potential in the field and landslide potential evaluated.

Table 3. Proposed new temporary roads, former logging access route updates, and short spurs.

Location	Length (feet)	Access for M Unit	Description
Intersection 39N53	1,577	M Unit 15 (Cable)	New temporary road
Intersection 39N20	550	M Unit 17	New temporary road
Intersection 39N73	1,074	M Unit 21 (Cable)	New temporary road
Intersection FS39	605	M Unit 24	New temporary road
Intersection 39N58B	617	M Unit 36	New temporary road
Intersection 39N53A	560	M Unit 37	New temporary road
Intersection 39N37A	450	M Unit 75	New temporary road
Intersection 39N23	1,123	M Unit 9	Former logging access route
Intersection 39N53	1,381	M Unit 15 (Tractor)	Former logging access route
Intersection 39N58	519	M Unit 25	Former logging access route
Intersection 39N04 – Lafayette Pt.	2,154	M Units 43 and 8	Former logging access route
Intersection FS39A	240	M Unit 23	Four logging spurs at 60 feet each–operations
Intersection 39N04A	100	M Unit 39	Short logging spur–operations

Use of Former Logging Access Routes—0.98 mile. Former logging access routes in varying states of revegetation would be reused. There would be a reduction in root support and local evapotranspiration, particularly where older vegetation is removed. All of these routes were inspected for landslide potential in the field and landslide potential evaluated. Potential for road-related landsliding is considered to be very low. Closure following use would eliminate any pre-existing drainage problems and remove fill placed in draws, thereby restoring hydrologic conditions and reducing landslide risk.

Use of Short Spurs—340 feet. The spurs proposed for use were inspected for landslide potential in the field and landslide potential evaluated. Since spurs are, in most cases, on gentle ground and near ridge crests, the risk of road-related landsliding is considered to be very low. Closure following use would reestablish hydrologic conditions that existed prior to project implementation and allow revegetation to commence.

Road Maintenance. All haul roads will be maintained. This action would decrease the potential for road related landslides, by better controlling road surface drainage.

Landings. Approximately 73 existing landings would be used for the thinning units. All are associated with tractor yarding. Cable yarding would use the road prism for “hot decking” of logs such that no additional landings are proposed for cable units. (Basically, hot decking occurs when the running surface of the road is not wide enough for both the cable yarder and the logs. The logs have to be moved out of the way so another load can be brought to the road, where trucks haul them away—this eliminates the need for landing construction because the road prism itself serves as the landing.) Total clearing for existing landings over the entire Assessment Area is estimated to cover 18 acres (0.25 acre per landing). Landing locations are mostly along existing roads and were used in previous harvest operations. Locations have been placed on the project GIS coverage and are shown in the Logging Systems Specialist Report contained in the project record. No landings are proposed in Riparian Reserves or other sensitive lands.

Landing size could vary according to such factors as local conditions and the amount of timber volume being handled, but none are expected to exceed 0.5 acre. By limiting landings to gentler slopes, minimizing cut heights, and constructing stable fills, applying timber sale contract clause CT 6.602 Special Erosion Prevention and Control (May 4, 1998), landslides associated with landings are not anticipated.

Mastication in FRZs. Alternative B includes mechanical mastication of fuels on flatter areas (under 45 percent) along ridgetops. This is estimated to occur on 3,184 acres. The use of small, low-ground-pressure equipment would limit soil disturbance and compaction. Residual soil cover would be left following treatment that to minimize effects of soil disturbance. Ridgetop location of treatments would limit impacts to Riparian Reserves.

Hand Piling and Burning. Hand piling would be applied to steeper portions of the 16 miles of roadside treatment that occur outside of FRZs and Rx Units. This treatment may also be applied as part of preparing underburn units. In areas currently supporting heavy fuels, this activity would greatly reduce the risk of high-severity fire. This is particularly true where accumulations of down saplings and poles are present.

Underburning. This is the dominant treatment proposed in this alternative. Underburning will occur in cable portions of thinning units (post-harvest) and in FRZs and Rx Units. Thinning, mastication, and hand thin / pile represent preparatory steps to allow the introduction of prescribed fire without catastrophic consequences. This activity would reduce the potential for stand-replacing wildfire. However, there is always some risk of local high-severity fire occurring during implementation of prescribed burns, and if this should occur on unstable areas, it could increase landslide potential. Application of geologic resource protection measures is expected to minimize the risk of high-severity fire in unstable areas.

The direct and indirect effects of various management activities are summarized in Tables 4 and 5, respectively. The tables provide a brief description of the effect and an evaluation of its intensity. Intensity of effects is described using the terms negligible, minor, moderate, or major. A more specific interpretation of the meaning of these terms is described in Section 1.5.5 above.

Table 4. Direct effects of Alternative B on geologic resources and hazards.

Management Activity	Type of Direct Effect	Intensity	Determination
Thinning	Reduced vegetation density	*Negligible to minor*. Remaining trees rapidly occupy available canopy and root space.	Professional judgment / experience
Tractor yarding	Soil disturbance and compaction; loss of organic matter	*Negligible to minor*. Tractor yarding limited to gentle slopes near ridgetops. Resource protection measures require residual groundcover and erosion control on skid trails and landings.	Professional judgment / experience
Cable yarding	Soil disturbance; erosion	*Negligible to minor*. Limited soil disturbance. Resource protection measures require residual soil cover and limit openings in Riparian Reserves.	Professional judgment / experience
Landings	Cuts and fills	*Minor*. Landings are pre-existing with no evident problems. Minimal cut and fill required as most landings are located adjacent to existing roads.	Professional judgment / experience
Mastication in FRZs	Mechanical soil disturbance; possible small changes in slope hydrology; short-term reduction in evapotranspiration	Negligible to minor. Low-ground-pressure equipment will be used and limited to 45 percent slopes. Mastication leaves considerable soil cover	Professional judgment / experience
New temporary road construction or use of former logging access routes	Cuts and fills	*Minor*. Very little construction proposed. All segments short. No segments on unstable slopes. All will be closed.	Professional judgment / experience
Road closure	Pulling of fills, outsloping, rocking of crossings; stabilizing existing landslides	*Minor short-term* effects of creating bare soil. Resource protection measures require mulch or other soil cover and erosion control. Long-term beneficial effects.	Professional judgment / experience
Road maintenance	Cleaning of culverts, blading, ditch clearing	*Negligible*. Beneficial effects.	Professional judgment / experience
Hand piling and burning	Reduction of organic material, local areas of high intensity fire, loss of fine organic matter	*Negligible*. Insignificant ground disturbance.	Professional judgment / experience
Underburning	Reduction of fine organic material; local hot fire; loss of fine organic matter	*Negligible to minor*. Burn prescription will include measures for maintenance of canopy, soil cover, and root density where slope stability is a concern.	Professional judgment / experience

Table 5. Indirect effects of Alternative B on geologic resources and hazards.

Management Activity	Type of Indirect Effect	Intensity	Determination
Thinning	Minor short-term reduction in root support and evapotranspiration; minor increased landslide potential.	*Negligible to minor*. Remaining trees rapidly occupy available canopy and root space	Professional judgment / experience
Tractor yarding	Changes in soil permeability and runoff patterns, local changes in mass balance; potential to channel water and increase landslide potential.	*Negligible to minor*. Tractor yarding limited to gentle slopes near ridgetops. Resource protection measures require residual groundcover and erosion control on skid trails and landings. No tractor yarding proposed on or near unstable slopes.	Professional judgment / experience
Cable yarding	Local changes in soil permeability and channeling of water; potential to increase landslide potential.	*Negligible to minor*. Limited soil disturbance. Resource protection measures require residual soil cover and limit openings in Riparian Reserves.	Professional judgment / experience
Landings	Large changes in slope hydrology; potential for fill and cut failure landsides.	*Minor*. Landings are pre-existing with no evident problems. Minimal cut and fill required as most landings are located adjacent to existing roads. No landings proposed on or near unstable slopes.	Professional judgment / experience
Mastication in FRZs	Soil compaction and reduction in evapotranspiration could produce increases in surface runoff, potentially generating sediment to streams.	Negligible to minor. Low-ground-pressure equipment will be used and limited to 45 percent slopes. Mastication leaves considerable soil cover. Tree canopy will be retained.	Professional judgment / experience
New temporary road construction or use of former logging access routes and spurs	Large changes in slope hydrology; potential for fill and cut failure landslides.	*Minor*. Very little construction proposed. All segments short. No segments on unstable slopes. No road alignments intersect springs, seeps, or cross any stream channels. Special C-clause required for stabilization of cuts and fills. All will be closed.	Professional judgment / experience
Road closure	Restoration of slope hydrologic patterns; large reduction in risk of stream crossing and fill failures; reduction in landslide failure.	*Minor short-term* effects of creating bare soil. Resource protection measures require mulch or other soil cover and erosion control. Long-term beneficial effects.	Professional judgment / experience
Road maintenance	Reduction in potential for stream crossing fill failure.	*Negligible*. Beneficial effects.	Professional judgment / experience
Hand piling and burning	Reduction of fire risk.	*Negligible*. Insignificant ground disturbance. Beneficial effects.	Professional judgment / experience
Underburning	Reduction of fire risk; local increase in landslide potential where hot fire inadvertently occurs on unstable land.	*Negligible to minor*. Burn prescription will include measures for maintenance of canopy, soil cover, and root density where slope stability is a concern. Critical areas will be reviewed for pretreatment of fuels where necessary to prevent flare ups.	Professional judgment / experience

Asbestos Hazard Associated with Roads and M Units. There are outcrops of ultramafic rock along some roads, and this rock type often contains asbestos ("um" in Table 6). The following table lists such roads and identifies those that are closer than one mile to sensitive receptors (residences or campgrounds). Harvest units are similarly listed in the table. Listings are based on the Klamath National Forest bedrock coverage in the Klamath National Forest GIS library and supplemented by field survey. Also, see Appendix I for the report titled, "Naturally Occurring Asbestos in Eddy Gulch LSR Project."

Table 6. Locations of treatment units and roads underlain by ultramafic rocks.

Road or Unit	Sensitive Receptor	Junction with Paved Road?	Location
FRZ 9	No	N/A	Lower portion of FRZ 9 south of unit M Unit 66
Rx Unit 4	No	N/A	Southern half of this Rx Unit along west branch of Crawford Creek
39N23	No	1C02 (South Fork Salmon Road)	From Cecilville north to intersection of 38N17
FRZ 2	Black Bear Ranch	N/A	Small pockets of um west of M Unit 51. Um rocks prevalent vic. Blue Ridge Lookout
Rx Unit 1	Black Bear Ranch	N/A	Belt of um rocks underlies approximately 10% of unit.

Cumulative Effects

Cumulative effects on geologic resources are gauged by evaluating GEO risk ratios produced by the CWE model. Input to the model for each treatment unit or road consists of physical attributes (slope gradient, soil type, bedrock type, and geomorphic terrain type) that are generally compiled from GIS coverages. The type of treatment or disturbance is also part of model input. Field assessments served to validate or upgrade mapped information and to arrive at a qualitative assessment of the potential impacts of the proposed treatment. The presence of indicators (such as nearby landslide features, abundant seeps and springs, structurally weak bedrock, hummocky slopes, irregular stream drainage patterns, or very steep slopes) would lead to a higher qualitative rating of the potential landslide risk. These ratings are also part of the input to the CWE model.

GEO risk ratios for Alternative B are shown in the Table 7. The column titled "Current" represents existing conditions. "Post-project" includes natural recovery of existing disturbances and the addition of project (Alternative B) disturbances. The last column includes effects of foreseeable future actions plus recovery projected out to 2021, the expected date of project completion.

Only the Kanaka-Olsen watershed shows a risk ratio above 1.0 (GEO = 1.43), and that denotes the existing condition. Only 18 acres of FRZ treatment are proposed in the Kanaka-Olsen watershed. Note also that the risk ratio would improve steadily over the life of the project, going below threshold upon project completion. All other risk ratios would be quite low, and most are lower upon project completion than under existing conditions.

Table 7. Alternative B GEO risk ratio data from the CWE Model run of October 20, 2008.

Watershed	Background Sediment	Current Sediment	Current Plus Future Actions Sediment	Current	Post-Project	Post-project Plus Future Actions
	Cubic Yard			Risk Ratio		
7th-field watersheds						
Black Bear Creek	19,070	35,962	34,059	0.44	0.44	0.39
Cody-Jennings Creek	20,997	41,734	39,171	0.49	0.49	0.43
Crawford Creek	15,321	24,121	23,489	0.29	0.29	0.27
Eddy Gulch	6,412	16,606	14,158	0.79	0.62	0.60
Gooey-Ketchum Creek	6,289	12,537	12,525	0.50	0.50	0.50
Gould-East Fork South Fork Salmon River	5,963	11,375	11,343	0.45	0.45	0.45
Indian Creek	9,818	26,995	22,831	0.87	0.87	0.66
Kanaka-Olsen Creek	18,606	75,429	51,933	1.53	1.43	0.90
Lower North Russian Creek	6,898	13,443	12,530	0.47	0.41	0.41
Lower South Russian Creek	3,424	7,189	5,773	0.55	0.36	0.34
Matthews Creek	8,229	15,891	15,797	0.47	0.47	0.46
Robinson-Rattlesnake Creek	7,621	12,761	12,345	0.34	0.32	0.31
Shadow Creek	10,437	18,971	18,963	0.41	0.41	0.41
Sixmile Creek	7,536	13,022	12,945	0.36	0.36	0.36
Tanner-Jessups Creek	9,580	21,274	16,783	0.61	0.41	0.38
Taylor Creek	8,440	11,847	11,009	0.20	0.15	0.15
Timber-French Creek	12,872	20,849	20,625	0.31	0.31	0.30
Upper North Russian Creek	4,959	13,610	10,728	0.87	0.60	0.58
Whites Gulch	11,581	19,662	15,439	0.35	0.19	0.17
5th-field watersheds						
North Fork Salmon	392,308	690,282	650,418	0.38	0.38	0.33
South Fork Salmon	232,540	488,838	390,997	0.55	0.48	0.34

Areas with Watershed Concerns. The GEO component of the CWE model indicates that under existing conditions, the potential for adverse CWE (landsliding) is highest in Kanaka-Olsen and Indian Creeks. Moderately high-risk ratios (0.8–0.9) are reported for Eddy Gulch and Upper North Russian Creek. In each instance, implementation of Alternative B, in combination with natural recovery processes, result in significantly reduced risk ratios upon project completion. The reason that the model predicts a drop in risk, despite the fact that the project involves thinning and some road activity, is as follows: (1) The model assumes that there will be no measurable increase in landslide potential associated with thinning; (2) It assumes that opening and then closing currently abandoned roads (the former logging access routes) will reduce landslide risk. This reduction in risk offsets the adverse effects of new temporary road construction. As a result, the mix of road activities results in a net reduction in CWE risk.

Indian Creek and portions of Black Bear Creek are classified as AWWC. Reported risk ratios suggest that substantial recovery has occurred since these designations were made in the mid-1990s. The Kanaka-Olsen watershed meets screening criteria for AWWC status (GEO = 1.53). However, Kanaka-Olsen is a watershed area of slopes draining directly to the North Fork Salmon River from both sides of the river and the watershed conditions driving the high-risk ratios stem from fire and other disturbances occurring on granodiorites on the north side of the river. As mentioned earlier, Indian Creek and Kanaka-Olsen are scheduled to receive very minor amounts of fuel reduction treatments only with no road construction of any kind proposed.

In summary, the potential for adverse CWEs exists in some watersheds, due to existing road densities. New temporary road construction and opening of former logging access routes, followed by closure of all temporary roads, results in a complex set of offsetting effects. The CWE model predicts a reduction in risk of adverse effects. However, there may be some small adverse effects associated with the reopening of former logging access routes that are in various states of revegetation. These adverse effects are not reflected by the model and would gradually recover as the closed roads revegetate.

Conclusion. Alternatives B would likely not produce detectable adverse effects on rates of landslide initiation or landslide-generated sediment delivery to streams. Conversely, fuel treatments would likely reduce the potential for accelerated landslide rates by reducing the risk of stand-replacing wildfire on potentially unstable slopes. This conclusion is based on (1) limited vegetation removal under fuel reduction and thin-from-below prescription; (2) limited road construction—all of it is on stable, upper slope locations; and (3) GEO risk ratios well below threshold with no increase during the life of the project. Direct, indirect, and cumulative effects on slope stability from project activities are expected to be negligible.

1.8.3 Alternative C: No New Temporary Roads Constructed

Geology Program Goals

Alternative C has a high probability of meeting all of five geologic objectives at a high level, provided geological resource protection measures are applied.

Direct and Indirect Effects —Landslide Risk

The direct and indirect effects of Alternative C are not significantly different from Alternative B. The effects of new temporary road construction are eliminated, but the effects of these were judged insignificant under Alternative B. Landslide risk from road construction is even less under Alternative C. The tables describing the direct and indirect effects of Alternative B are equally applicable to Alternative C and, for the sake of brevity, are not repeated here. The elimination of fuels treatment on 99 acres of potential thinning units and 822 acres of Rx Units poses some small but elevated risk of wildfire and its related impacts to landslide potential as previously described. This increase in risk is judged to be negligible.

Direct and Indirect Effects by Project Activity

The direct and indirect effects associated with Alternative C are described below. These descriptions highlight the differences between the two action alternatives.

Thinning—832 acres. This is 99 acres less than Alternative B.

Tractor Yarding—361 acres. No change from Alternative B.

Cable Yarding—471 acres. No change from Alternative B.

Road Maintenance. No change from Alternative B.

New Temporary Road Construction / Closure—None.

Reopening Former Logging Access routes—0.98 mile. No change from Alternative B.

Landings. The number of tractor acres (351 acres) would be the same under Alternatives B and C, which means Alternative C also proposed to use approximately 73 existing landings. As with Alternative B, by limiting landings to gentler slopes, minimizing cut heights, and constructing stable fills, applying timber sale contract clause CT 6.602 Special Erosion Prevention and Control (May 4, 1998), landslides associated with landings are not anticipated.

Mastication in FRZs. The type and extent of this treatment is unchanged from Alternative B.

Hand Piling and Burning. Unchanged from Alternative B, so effects would be the same.

Underburning. Total area of underburning is reduced by 822 acres under Alternative C. Application of geologic resource protection measures is expected to minimize the risk of high-severity fire in unstable areas.

Asbestos Hazard Associated With Roads & Harvest Units. The description of the asbestos hazard is unchanged from Alternative B.

Cumulative Effects

A CWE model run was conducted for Alternative C. The results were virtually identical to those for Alternative B. The reason for this is that the largest reduction in treatment acres under Alternative C occurred for Rx Units where the model assigns very low disturbance factors. The elimination of new temporary roads under Alternative C results in very slight reductions in predicted sediment yield in the Shadow Creek and Black Bear watersheds. The changes are so small that calculated risk ratios remain unchanged to two decimal places and are thus judged to be inconsequentially different from the risk ratios reported for Alternative B. As such, the cumulative effects discussion of Alternative B is equally applicable to Alternative C. Since the table of risk ratios is essentially identical between action alternatives, it is not repeated here.

Areas with Watershed Concerns. None of the temporary roads deleted under Alternative C were located within AWWCs. The discussion of this topic under Alternative B is equally applicable for Alternative C.

Conclusion. The thinning and fuel treatment associated with Alternative C are not likely to cause landsliding due to the prescriptions required for unstable lands, low severity of prescribed fire, and the avoidance of unstable lands by temporary roads. It involves very little change in potential for adverse CWEs. In fact, the landslide model indicates a slight reduction in this potential associated with the alternative. A small increase in wildfire potential and its related effects on slope stability results from reducing fuel treatment acres, but this effect was judged to be negligible.

1.9 Resource Protection Measures

The following resource protection measures (RPMs) will be applied to address geologic hazard and resource issues. They will greatly reduce the potential for adverse direct, indirect, and CWEs. The site-specific Best Management Practices (BMPs) are contained in Appendix H.

Summary

- Layout cable corridors to maximize log suspension and minimize surface disturbance to small areas of wet soil that occur in some thinning units.

- Mulch or slash any skid trails on slopes over 35 percent. Slash or certified straw will be placed on them to achieve a 70–80 percent soil cover.

- Use existing landings wherever available, and design for stable cuts and fills to assure that no sediment from landings is delivered to stream courses.

- Scatter slash to 80 percent ground cover on any wet areas disturbed by yarding.

- Use all available tools in planning prescribed burning to avoid high severity fire on active landslides and other unstable areas. This includes close coordination between fire and watershed personnel during field layout of burn units to identify unstable areas which are at risk of burning at high severity.

- Maintain 60 percent tree canopy on units identified as having higher slope stability risk.

- **Close temporary roads.** This includes removal of berms and fills, removal of any constructed stream crossing (none anticipated), tillage or scarification of compacted areas, waterbars, and slash or mulch cover of disturbed areas to 70 percent.

- **Asbestos.** The Forest Service will provide a description of health hazards from asbestos exposure and maps to contractors identifying areas that may have asbestos and suggest they may consider sealed cabs on their equipment. If timber haul routes change during project implementation, any additional roads would be checked against the bedrock map to determine if they are underlain by ultramafic rock, and the asbestos standards applied. Dust abatement is required on all roads underlain by ultramafic rocks, and it is recommended that masticators have positive-pressure climate-controlled sealed cabs.

- **Coordination.** Following award of the contract for this project, personnel from earth science, timber administration, and fire will coordinate details of implementation, including protection of unstable areas during logging and burning activities.

New Temporary Road Construction and Reopening of Former Logging Access Routes and Spurs. Clause CT 6.602 Special Erosion Prevention and Control (May 4, 1998) will be included in the Timber Sale Contract. This clause requires the purchaser to identify site-specific measures to be used to provide increased stability of cuts and fills in temporary road construction to protect water quality. Mitigation measures will be developed as appropriate. The above guidelines also apply to the reopening of existing roads. On such roads, berms will be removed, and conditions that concentrate surface runoff would be eliminated. Following use, all temporary roads will be closed, fills removed from draws, and natural runoff patterns re-established (outsloping, dips, etc.). Dimensions on landings will be no larger than 0.5 acre for tractor and cable yarding.

Silvicultural Prescriptions in Riparian Reserves. Draft silvicultural prescriptions for the various types of Riparian Reserve were developed for this project, and are displayed in Appendix A. These guidelines will be further refined by watershed, fisheries and vegetation management personnel during layout to assure effective application. However, the basic intent will not be modified. The goal for these prescriptions is to maintain hydrologic, geomorphic, and ecologic processes that directly affect standing and flowing water bodies such as lakes and ponds, wetlands, streams, stream processes, and fish habitats. No trees within the Riparian Reserve would be marked which would likely fall into the stream under natural conditions. These will be left on site to provide large wood in the future when they fall naturally, or are taken down by landslides. No dominant or pre-dominant trees would be removed from Riparian Reserves.

Use of Equipment in Riparian Reserves. Equipment will not operate within 30 feet of the wetted channel of any intermittent stream. Cable yarding corridors will not be placed through Riparian Reserves, unless a field assessment by an earth scientist and sale planner or administrator determines that this can be accomplished without damage to residual trees or soil. Tractor skid roads will not cross Riparian Reserves except on some dry intermittent streams where no excavation would be needed and where agreed to by watershed / fisheries personnel.

Prescribed Fire in Riparian Reserves. During underburning, fire will generally be backed down into Riparian Reserves, and ignition will usually not occur there. However, there will be exceptions where deemed necessary to control fire intensity. Underburn prescriptions will be designed to result in low severity burns in all Riparian Reserves. Specific problem spots will be field reviewed by fuels and earth science personnel during development of the burn plan and appropriate mitigations developed. The potential for high severity fire can be mitigated by modifying the ignition pattern, or handpiling of slash accumulations on unstable areas prior to ignition.

Rock Sources. No rock sources will be developed for this project.

Asbestos. The Forest Service will provide a description of health hazards from asbestos exposure and maps to contractors identifying areas that may have asbestos and suggest they may consider sealed cabs on their equipment. If timber haul routes change during project implementation, any additional roads would be checked against the bedrock map to determine if they are underlain by ultramafic rock, and the asbestos standards applied. Dust abatement is required on all roads underlain by ultramafic rocks, and it is recommended that masticators have positive-pressure climate-controlled sealed cabs.

Tractor Yarding. Emphasis will be placed on using existing skid trails and landings. Tractors will generally stay on ground no steeper than 35 percent, unstable areas will be avoided, no new full bench skid roads will be constructed, and water bars will be installed to avoid drainage diversions. Detailed resource protection measures related to tractor logging are contained in the soils and hydrology reports, and in the BMP summary in the Aquatic Resources Report.

Coordination. Timber prep and earth science shops will similarly establish contact prior to the marking of units to assure that prescriptions in Riparian Reserves are properly implemented. Similar coordination will be needed to address any post-planning changes in project design. Fire and watershed shops will closely coordinate burn plans affecting Riparian Reserves. After the sale is sold, the sale administration and earth science shops will establish and maintain contact to provide the earth scientist the opportunity to field review final flagged road alignments and landings in the field and offer recommendations as appropriate.

1.10 NEPA Intensity Factors

Appendix G displays the 10 *National Environmental Policy Act* (NEPA) intensity factors and their applicability to the geologic resource for Alternatives B and C.

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Appendix A

Eddy Gulch LSR Project
Prescriptions for Riparian Reserves

Appendix A
Eddy Gulch LSR Project
Prescriptions for Riparian Reserves

December 2008

The Record of Decision for the Northwest Forest Plan identifies interim widths for Riparian Reserves along streams and wetlands, and classifies certain landforms as part of the Riparian Reserve. It also includes other landforms identified by individual National Forests as unstable and unsuited for programmed timber production in their respective land and resource management plans as part of the Riparian Reserve.

These draft guidelines provide the basis for marking within the Riparian Reserve. It is anticipated that some adjustments, such as spacing distances and crown closure, will be needed to address unanticipated conditions that may be encountered on the ground. This will be accomplished jointly by watershed / timber personnel assisting in layout during application of the mark, and all changes will be documented. However, the basic goals and objectives described in this document will not change.

Definition of Riparian Reserve. The Riparian Reserve is defined (paraphrased from the Northwest Forest Plan Record of Decision, pages B-12, B-13) as follows:

The Riparian Reserve consists of lands where riparian dependent resources receive primary emphasis, and where special Standards and Guidelines apply. They include those portions of a watershed required for maintaining hydrologic, geomorphic, and ecologic processes that directly affect standing and flowing water bodies such as lakes and ponds, wetlands, streams, stream processes, and fish habitats. Also included are the habitat needs of a variety of animals such as mollusks, amphibians, lichens, fungi, bryophytes, vascular plants, American marten, red tree voles, bats, marbled murrelets and northern spotted owls. Refer to Northwest Forest Plan Record of Decision, pages B-12, B-13.

Riparian Reserves include the land adjacent to all permanently flowing streams, constructed ponds and reservoirs, wetlands, lakes and natural ponds, seasonally flowing or intermittent streams, floodplains, and unstable and potentially unstable land (including earthflows).

The different types of Riparian Reserves occurring within the project area are discussed below along with specific goals and guidelines for vegetation management within each type of Riparian Reserve.

Stream and Wetland Riparian Reserves

Perennial Streams

Description. Includes the area 340 feet or two site-potential trees (whichever is greatest) on each side of all perennial fish-bearing streams. Includes both the channel and hillslope environment.

Overlap With Other Types of Riparian Reserve. Overlaps are possible with all of the unstable land Riparian Reserves. In the case of overlap with inner gorge, toe zone, or active slide, or debris slide scars in dissected granitic terrain, the unstable land objectives would usually take precedence, but exceptions could occur.

Vegetative Goal. Mixture of large conifers and hardwoods of variable age, along with aquatic shrubs, crown closure of greater than 80 percent. Typical assemblage would be scattered mature conifers and hardwoods on banks and upslope with local dense aquatic shrubs. Dense shade and trees overhanging the stream are key goals. Snag and decadent tree retention is required to maintain large wood recruitment to the stream.

Use of Mechanized Equipment. Equipment exclusion for 170 feet slope distance on each side of the channel. Exclusion of cable yarding corridors except by agreement between watershed, fisheries, and timber specialists.

Vegetation Management Guidelines.

- *Stand Density and Crown Closure*—For 170 feet from the stream on each side, retain a minimum 80 percent crown closure (all sizes and species) and 15–20 foot tree spacing in trees greater than 20 inches dbh. From 170–340 feet retain a minimum 70 percent crown closure and 25 foot tree spacing in trees greater than 20 inches dbh.
- *Tree Retention on Critical Sites*—Retain all trees greater than 15 inches dbh in diameter on inner gorge slopes. Retain all trees contributing directly to channel bank support.
- *Species*—For 170 feet or 1 site potential tree on each side of stream, favor shade-producing, water-loving trees such as willow, alder, and maple.
- *Soil Cover*—Maintain 80 percent groundcover in the form of duff, litter, and down wood. Rehab firelines within 25 feet of the active channel by constructing water bars and augmenting ground cover.
- *Large Wood Recruitment to Streams*—Retain one large (greater than 20 inch dbh) snag or senescent tree per 100 feet of channel length within 170 feet slope distance from the active channel.

Intermittent Streams

Description. Includes the area 170 feet or one site potential tree (whichever is greatest) on each side of the intermittent stream. Includes both the channel and hillslope environment.

Overlaps With Other Types of Riparian Reserve. Overlaps are possible with all of the unstable land Riparian Reserves. In the case of overlap with inner gorge, toe zone, or active slide, or debris slide scars in dissected granitic terrain, the unstable land objectives would usually take precedence, but exceptions could occur.

Vegetative Goal. Mixture of large conifers and hardwoods of variable age, along with aquatic shrubs, crown closure of greater than 70 percent. Typical assemblage would be scattered mature conifers and hardwoods on banks and upslope with local dense aquatic shrubs. Dense shade and trees overhanging the stream are key goals. Snag and decadent tree retention is required to maintain large wood recruitment to the stream and downstream reaches.

Use of Mechanized Equipment. Equipment exclusion for 50 feet slope distance on each side of the channel or beyond the last break in slope into the channel (whichever is greatest). Exclusion of cable yarding corridors except by agreement between watershed, fisheries, and timber.

Vegetation Management Guidelines.

- *Stand Density and Crown Closure*—For 170 feet from the stream on each side, retain a minimum 70 percent crown closure (all sizes and species) and 20–25 foot tree spacing in trees greater than 20 inches dbh.
- *Tree Retention on Critical Sites*—Retain all trees greater than 15 inches dbh in diameter on inner gorge slopes. Retain all trees contributing directly to channel bank support.
- *Species*—For 170 feet or 1 site potential tree on each side of stream, favor shade-producing, water-loving trees such as willow, alder, and maple.
- *Soil Cover*—Maintain 80 percent groundcover in the form of duff, litter, and down wood. Rehab firelines within 25 feet of the active channel by constructing water bars and augmenting ground cover.
- *Large Wood Recruitment to Streams*—Retain one large (greater than 20 inch dbh) snag or senescent tree per 100 feet of channel length within 170 feet slope distance from the active channel.

Wetlands Greater Than One Acre in Size

Description. This type of wetland occurs at higher elevations of the project area, usually in the form of spring-fed patches of alder and other phreatophytes. Riparian Reserve boundaries extend 100 feet from the outer extent of seasonally saturated soil on each side of the wetland.

Overlap With Other Types of Riparian Reserve. Overlaps are possible with all of the unstable land Riparian Reserves, but are unlikely in the case of inner gorge and dissected granitic terrain. Where overlap occurs with inner gorge, toe zone, or active slide, or debris slide scars in dissected granitic terrain, the unstable land objectives would usually take precedence, but exceptions could occur.

Vegetative Goal. Mixture of large conifers and aquatic hardwoods (such as willow and alder) along with aquatic shrubs, crown closure of greater than 90 percent along margins of wetland whit itself may have no trees. Typical assemblage would include aquatic plants such as horsetail and ferns and aralia with alder, willow and maple on margins. In general, there will be no vegetation management within the wetland itself. The guidelines presented below pertain to the 100-foot buffer zone surrounding the wetland feature. Exceptions will be made by agreement between watershed, fisheries, and timber specialists.

Use of Mechanized Equipment. Equipment exclusion throughout. Exclusion of cable yarding corridors except by agreement between watershed, fisheries, and timber specialists.

Vegetation Management Guidelines.

- *Stand Density and Crown Closure*—For 100 feet from the outer extent of seasonally saturated soil, retain a minimum 70 percent crown closure (all sizes and species) and 20–25 foot tree spacing in trees greater than 20 inches dbh.
- *Tree Retention on Critical Sites*—Retain all trees contributing directly to mass stability on sites with indicators of elevated landslide risk.
- *Species*—Favor phreatophytic trees and shrubs such as willow, alder, and maple.
- *Soil Cover*—Maintain 80 percent groundcover in the form of duff, litter, and down wood.

Wetlands Less Than One Acre in Size

Description. This includes small seep and spring areas that occur dispersed throughout the project area, often along channels and within dormant landslides. The Riparian Reserve extends 50 feet beyond the outer edge of the riparian vegetation.

Overlap With Other Types of Riparian Reserve. Overlaps are possible with all of the unstable land Riparian Reserves, but are unlikely in the case of inner gorge and dissected granitic terrain. Where overlap occurs with inner gorge, toe zone, or active slide, or debris slide scars in dissected granitic terrain, the unstable land objectives would usually take precedence, but exceptions could occur.

Vegetative Goal. Mixture of variable aged large conifers and water-loving hardwoods (such as willow and alder) along with aquatic shrubs, crown closure of greater than 90 percent along margins of wetland whit itself may have no trees. Typical understory assemblage would include aquatic plants such as horsetail and ferns and aralia with an overstory of alder, willow and maple. In general, there will be no vegetation management within the wetland itself. Exceptions will be made by agreement between watershed, fisheries, and timber specialists.

Use of Mechanized Equipment. Equipment exclusion throughout. Exclusion of cable yarding corridors except by agreement between watershed, fisheries, and timber specialists.

Vegetation Management Guidelines.

- *Stand Density and Crown Closure*—For 50 feet from the outer extent of seasonally saturated soil, retain a minimum 70 percent crown closure (all sizes and species) and 20–25 foot tree spacing in trees greater than 20 inches dbh.
- *Tree Retention on Critical Sites*—Retain all trees contributing directly to mass stability on sites with indicators of elevated landslide risk.
- *Species*—Favor phreatophytic trees and shrubs such as willow, alder, and maple.

- *Soil Cover*—Maintain 80 percent groundcover in the form of duff, litter, and down wood.

Unstable Land Riparian Reserves

Active Landslides

Description. Actively moving or recently active landslides (see definition in Record of Decision for the Northwest Forest Plan). Includes both shallow, rapid landslides (debris slides) and deep, slow moving landslides (slumps and earthflows). Includes the entire active area of the landslide. The Klamath National Forest interprets this to include a zone upslope and adjacent to the landform (about 50 feet slope distance beyond the boundaries) where roots from vegetation growing there contribute directly to the stability of the landform.

Overlap With Other Types of Riparian Reserve. Active landslides can overlap with all other types of Riparian Reserve. Vegetative goals for active slides generally take precedence over other vegetative goals.

Vegetative Goal. Mixture of large native conifers, hardwoods, of multiple ages, and understory species adapted to the site with crown closure of greater than 80 percent. A substantial component of water loving hardwoods where shallow groundwater is present. For dry shallow debris slides, vegetation similar to the surrounding hillslope is desirable. For Slumps and earthflows a substantial component of water-loving tree species is desirable (shallow groundwater table). For conifers, large, physiological vigorous, and deeply rooted trees are preferred to maintain high rates of evapotranspiration and optimal root strength. In general, only fuel reduction treatments are appropriate. Exceptions may occur only when a site-specific prescription is developed in the field by a geologist and silviculturalist and documented. In treating adjacent lands for 100 feet around perimeter apply the vegetation management guidelines presented below.

Use of Mechanized Equipment. Equipment exclusion throughout. Exclusion of cable yarding corridors except by agreement between watershed, fisheries, and timber specialists.

Vegetation Management Guidelines.

- *Stand Density and Crown Closure*—Retain a minimum 80 percent crown closure (all sizes and species) and 15–20 foot tree spacing in trees greater than 20 inches dbh. Favor large vigorous conifers for retention.
- *Species*—Favor shade-producing, water-loving trees and shrubs such as willow, alder, and maple.
- *Soil Cover*—Maintain 80 percent groundcover in the form of duff, litter, and down wood. Rehab firelines within 25 feet of the active channel by constructing water bars and augmenting ground cover.

Inner Gorges

Description. Steep (greater than 65 percent) landform adjacent to streams, usually marked by a sharp slope break, steepening downslope. Usually a narrow band along channel ranging from 50 to about 200 feet wide on each side (total width 100–400 feet wide). Often contains springs and wetlands. Includes the entire landform. The Klamath National Forest interprets this to include a zone upslope and adjacent to the landform (about 50 feet slope distance beyond the boundaries) where roots from vegetation growing there contribute directly to the stability of the landform. May overlap with dissected granitic Riparian Reserve. Prescriptions for inner gorge apply in these instances.

Overlap With Other Types of Riparian Reserve. Inner gorges can overlap with all other types of Riparian Reserve. Vegetative goals for active slides generally take precedence over those for inner gorge.

Vegetative Goal. Mixture of large native conifers, hardwoods, of multiple ages, and understory species adapted to the site with crown closure of greater than 80 percent. Retain a substantial component of water loving hardwoods where local site conditions allow.

Use of Mechanized Equipment. Equipment exclusion throughout. Exclusion of cable yarding corridors except by agreement between watershed, fisheries, and timber.

Vegetation Management Guidelines.

- *Stand Density and Crown Closure*—Retain a minimum 80 percent crown closure (all sizes and species) and 15–20 foot tree spacing in trees greater than 20 inches dbh. Favor large vigorous conifers for retention.

- *Species*—Favor shade-producing, water-loving trees and shrubs such as willow, alder, and maple.

- *Soil Cover*—Maintain 80 percent groundcover in the form of duff, litter, and down wood. Rehab firelines within 25 feet of the active channel by constructing water bars and augmenting ground cover.

Toe Zones of Dormant Landslides

Description. Steep (usually greater than 50 percent) landform which may occur adjacent to streams or at great distances, dispersed across the landscape. Size range from less than an acre to 50 acres or more. Includes the entire landform. The Klamath National Forest interprets this to include a zone upslope and adjacent to the landform (about 50 feet slope distance beyond the boundaries) where roots from vegetation growing there contribute directly to the stability of the landform.

Overlap With Other Types of Riparian Reserve. Toe zones can overlap with inner gorges and stream and wetland Riparian Reserves. Vegetative goals for toe zones will generally take precedence over those for inner gorge or stream and wetland Riparian Reserves.

Vegetative Goal. Mixture of large native conifers, hardwoods, of multiple ages, and understory species adapted to the site with crown closure of greater than 80 percent. Dormant landslides typically have shallow groundwater and are capable of supporting aquatic species.

Use of Mechanized Equipment. Equipment exclusion throughout. Exclusion of cable yarding corridors except by agreement between watershed, fisheries, and timber specialists.

Vegetation Management Guidelines.

- *Stand Density and Crown Closure*—Retain a minimum 80 percent crown closure (all sizes and species) and 15–20 foot tree spacing in trees greater than 20 inches dbh. Favor large vigorous conifers for retention.
- *Species*—Favor shade-producing, water-loving trees and shrubs such as willow, alder, and maple.
- *Soil Cover*—Maintain 80 percent groundcover in the form of duff, litter, and down wood. Rehab firelines within 25 feet of the active channel by constructing water bars and augmenting ground cover.

Appendix B

Cumulative Watershed Effects Model Results
Modeled Wildfire Expected Under
No-Action Alternative A

Appendix B
Cumulative Watershed Effects Model Results
Modeled Wildfire Expected
Under No-Action Alternative A

For analysis purposes, Alternative A includes reasonably foreseeable future actions (such as the North Fork Roads Stormproofing Project) and a highly probable wildfire scenario generated by the fire behavior model FLAMMAP. The wildfire produced by the model is 7,200 acres in extent. Of those 7,200 acres, 1,355 acres (19 percent) would be surface fire; 5,065 acres (70 percent) would be a passive crown fire; and 780 acres (11 percent) would be an active crown fire. The effect of wildfire on slope stability is a function of the spatial interaction of high-intensity fire and latently unstable slopes. This complicates the analysis of effects because, although the fire's probability of occurrence is reasonably high, where the fire occurs is a function of the point of ignition, an assumption used as input to the fire model. To assess the effect on slope stability of a predicted wildfire at the watershed scale requires some assumptions about where high-intensity fire is likely to occur. In particular, the Klamath National Forest's CWE model was used to look at risk ratios related to slope stability. The structure of the model requires spatially specific information on soil-disturbing actions or processes to allocate disturbance to specific watersheds.

Three separate wildfires, using three different ignition points, were modeled using FLAMMAP. For most analyses, these three scenarios were averaged to produce a non-spatially specific estimate of the potential magnitude and severity of a probable wildfire. One of those modeled wildfires, one that initiates at the Shadow Creek Campground and burns mostly, but not entirely, within the Shadow Creek watershed, was selected for input to the CWE model. This discussion is presented because conclusions drawn from the CWE output must be tempered by the following considerations:

1. The selection of Shadow Creek represents a kind of worst-case scenario because within the watershed are relatively large acreages of past regeneration harvest, and the largest proportion of mechanical treatments under the Proposed Action when compared with other 7th-field watersheds within the analysis area,

2. Errors of estimation are usually compounded when one model's output is used as input to another.

The bottom line is that GEO risk ratios reported below for wildfire effects under Alternative A should be interpreted as boundary conditions—a statement of the reasonable outer limit of fire effects. Should an actual fire of similar magnitude and severity occur across multiple watersheds, or across less sensitive lands, then effects would be far less.

The table below shows pre- and post-fire GEO risk ratios for the modeled “Shadow Creek Fire.”

7th-field Watershed	GEO Risk Ratios	
	Pre-fire	Post-fire
Sixmile Creek	0.364	0.388
Gould-EF SF Salmon	0.454	0.838
Shadow Creek	0.408	1.067
Gooey-Ketchum	0.497	0.538
Crawford Creek	0.287	0.287
Whites Gulch	0.186	0.188

Most notable is the sizeable increase in risk ratio in Shadow and Gould-EF SF Salmon. Each represents an approximate doubling of the risk of landslide-related sediment. This underscores the environmental risks of the no-action alternative.

Appendix C

Summary of Project Features of Special Interest

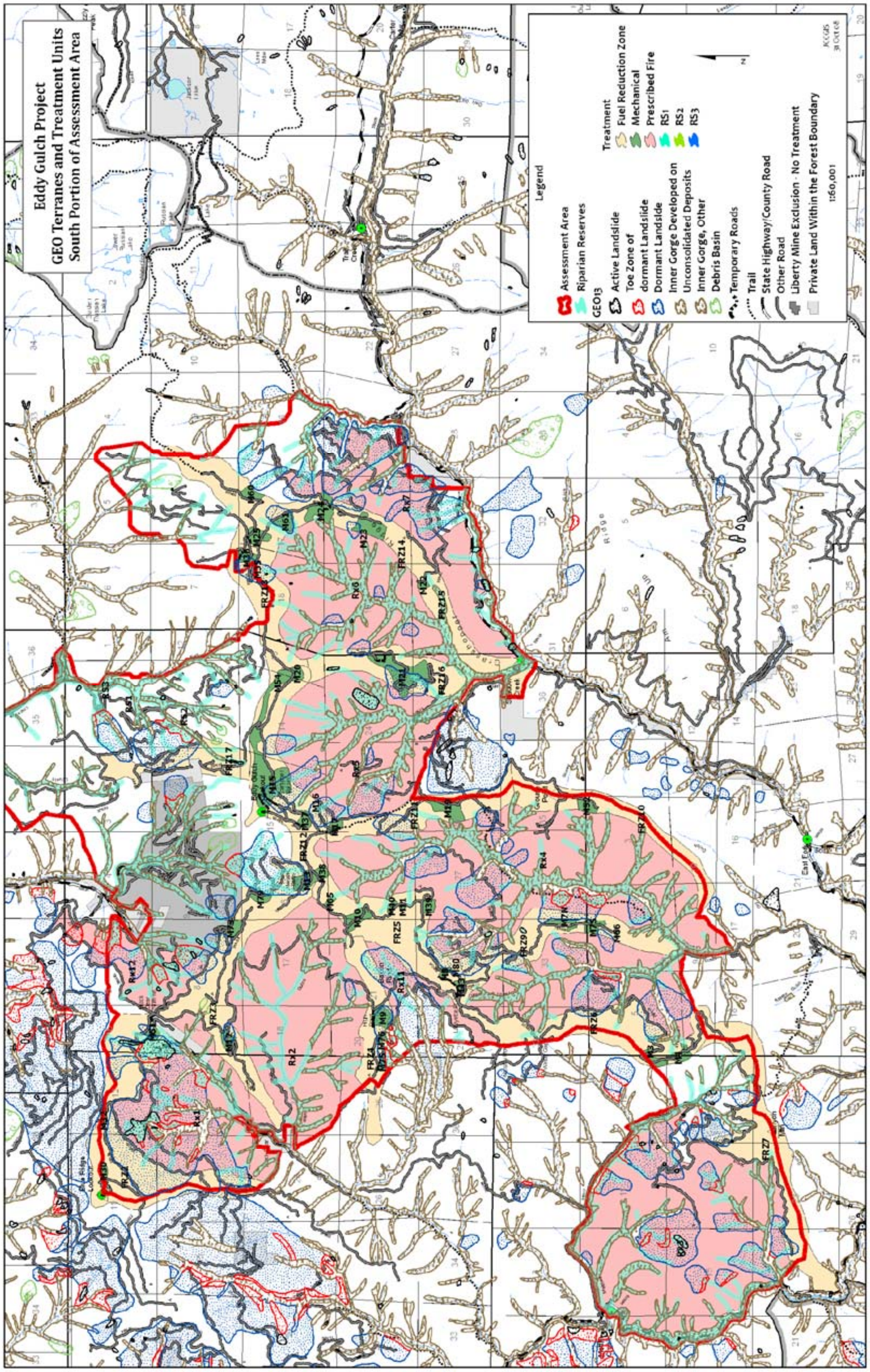
Appendix C
Summary of Project Features of Special Interest

Units with Recommended Changes to Riparian Reserves	Units with Indicators of Elevated Landslide Potential	Units Requiring Streamside Management Zones	Units with New Temporary Roads	Units with Former Logging Access Routes
M Unit 15	M Unit 23	M Unit 04	M Unit 15	M Unit 08 / M Unit 43
M Unit 19	M Unit 61	M Unit 09	M Unit 21	M Unit 09
M Unit 25	M Unit 73	M1 Unit 5	M Unit 23	M Unit 15
M Unit 31		M Unit 15	M Unit 24	M Unit 17
M Unit 31		M Unit 19	M Unit 36	M Unit 25
M Unit 61		M Unit 21	M Unit 37	M Unit 39
M Unit 75		M Unit 22	M Unit 75	
M Unit 76		M Unit 24		
M Unit 76		M Unit 25		
M Unit 79		M Unit 31		
FRZ 2		M Unit 40		
FRZ 3		M Unit 51		
FRZ 4		M Unit 61		
FRZ 6		M Unit 65		
FRZ 11		FRZs and Rx Units		
Rx Unit 11				

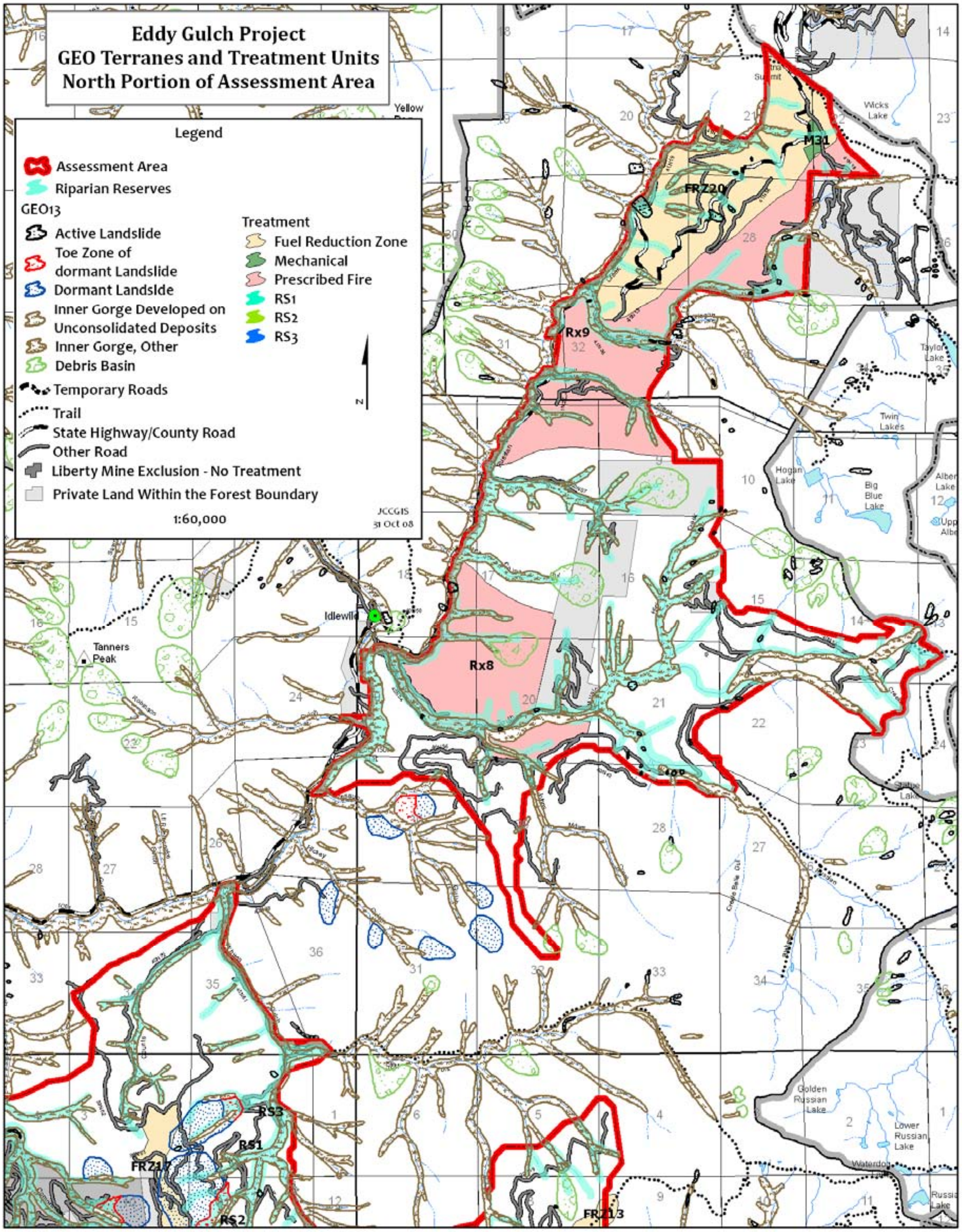
Appendix D

Maps: Geo Terranes and Proposed Treatment Units

Map D-1. Geo terranes and proposed treatment units—south portion of the Assessment Area.



Map D-2. Geo terranes and proposed treatment units—north portion of the Assessment Area.



Appendix E

Geologic Program Goals and Evaluation Criteria

Appendix E
Geologic Program Goals and Evaluation Criteria

Goal 1

Manage for Aquatic Conservation Strategy Objectives. This includes maintaining the natural sediment regime, and by extension, the natural fire regime under which aquatic ecosystems evolved.

Evaluation Criteria

- *Stormproof System Roads*—Focus should be placed on stormproofing high-risk road segments, making stream crossings resistant to debris flows, and stabilizing existing sediment producing landslides along roads.

- *Decommission Un-needed Roads*—Focus should be placed roads with a high risk for generating sediment.

- *Maintain System Roads*—Emphasis should be placed on maintaining roads with high potential to produce sediment.

- *Classify Roads Appropriately*—Change road classification as appropriate to foster maintenance and use levels commensurate with the type and use of the road.

- *Identify and Mitigate Other Human Caused Sediment Sources*—This would include identifying other man made embankments such as from mining, and stabilizing them.

- *Maintain Healthy and Vigorous Native Vegetation on the Unstable Lands*—This can be accomplished with no action in the case of healthy stands, or with individual tree removal if appropriate for stand health

- *Minimize Ground Disturbance on Unstable Lands*—This can be accomplished with no actions in unstable areas, or by use of helicopter yarding where trees are cut in unstable lands for stand health

- *Minimize Area of Severe Ground Disturbance in all Harvest Units*—This can be accomplished by limiting tractors to gentle (less than 35 percent) ground, avoiding construction of full bench skid trails, using existing skid trails where available.

- *Minimize Disturbances (cuts and fills) Associated With Roads and Landings*—This can be accomplished by limiting new road construction and minimizing disturbances associated with using existing roads and landings.

- *Minimize Potential for Off-site Hydrologic Effects on Dormant Landslides*—This can be accomplished by identifying dormant landslides, and:

  – Avoiding or minimizing regeneration harvest and road or landing construction within or upslope of such areas.

  - Closing roads or landings in such areas; Analyzing potential effects of such activities requires a site specific assessment of the drainage basin in question including mapping of dormant landslide features, tracking of management activity (roads and harvest) and fire, and tracking of debris slide history.

- *Reintroduce Fire into the Ecosystem With Prescribed Fire*—Design prescribed fire to:

  - Minimize the consumption of litter and coarse woody debris in unstable areas;

  - Minimize the risk of escape;

  - Minimize the risk of killing overstory vegetation in pockets larger than 0.1 acre; and

  - Maximize overall reduction in potential for large high-intensity fires.

- *Reduce Pre-existing Fuel Loading*—This can be accomplished with various techniques such as use of a masticator, hand piling, and broadcast burning.

- *Dispose of Activity Fuels*—Design project to dispose of activity fuels by appropriate means, such as hand piling and burning, masticator, tractor piling, grubbing, etc.

Results for Goal 1

Most evaluation criteria were fully or partially met by the Proposed Action.

Goal 2

Protect Water Quality and meet FSM Direction for Geology.

Evaluation Criteria

- *Proactive Watershed Restoration*—Actively restore watersheds by stabilizing sediment sources associated with past human activities (such as roads, landings, and mines)

- *USFS Standards*—Apply LMP and FSM 2880 Geological Standards and Guidelines.

Results for Goal 2

This goal was partially met, but it does not include pro-active actions to restore existing sediment sources. Project's primary goal of reducing wildfire risk represents a form of restoring critical watershed processes and linkages.

Goal 3

Protect human health, safety, welfare, and property from geologic hazards. Minimize the potential for project activities to cause landslides that could damage life or property, or introduce asbestos fibers into the air.

Evaluation Criteria

- *Minimize Landslide Risk to Human Life and Property From Landsliding*—Accomplishing this requires:
  - Identifying human habitation sites and other facilities which could be adversely affected by proposed activities;
  - Evaluating the risk and magnitude of these effects; and
  - Developing mitigation measures where appropriate.
- *Avoid Use of Ultramafic Rock Quarries*—To accomplish requires:
  - Field sampling and asbestos testing of proposed rock aggregate quarries which could be in ultramafic rock; and
  - Complying with state and county regulations related to asbestos.
- *Minimize Dust Production From Roads With Ultramafic Rock Surfaces*—This can be accomplished by strict application of standard dust abatement measures during the timber sale. Roads in ultramafic rock are identified on the rock source map, but those surfaced previously with rock from ultramafic pits would have to be identified in the field prior to timber sale use to assure strict application of dust control measures on such roads.
- *Minimize Dust Production From Skid Trails and Landings in Ultramafic Rock*—To accomplish this requires identifying which tractor units and landings are in ultramafic rock. If asbestos is likely to be present, mitigation measures may be needed.

Results for Goal 3

Most criteria for this goal were fully or partially met.

Goal 4

Protect geologic resources.

Minimize the potential for project activities to adversely affect geologic resources (such as rock and groundwater) and unique geologic features (such as Geologic Special Interest Areas and Research Natural Areas).

Evaluation Criteria

- *Protect Fragile Geologic Features from Disturbance*—Avoid or minimize ground and vegetation disturbing activities in the vicinity of fragile geologic features.
- *Maintain Access to Resources*—Avoid closing access to significant geologic resources such as rock or groundwater sources by activities such as decommissioning the only road access to a site.

- *Protect Designated Values in Geologic Areas*—Avoid activities that could conflict with the geologic values for which the areas were designated. In Research Natural Areas, this would require evaluating effects of noise, and increased human use.

- *Protect Groundwater Sources*—Manage the surface resource in such a manner as to protect groundwater and development facilities such as vertical and horizontal wells.

Results for Goal 4

This goal was met. Limestone Bluffs Research Natural Area is over 0.25 mile from the nearest fuel treatment unit (FRZ). No impacts to the Research Natural Area are anticipated.

Goal 5

Develop Geologic Resources in and environmentally and economically sound manner.

Evaluation Criteria

- *Rock Source Management*—Develop rock sources as needed for aggregate or rip rap, and develop a closure plan to be implemented upon completion of the project.

Results for Goal 5

Rock sources already exist in the Assessment Area. No rock pit development or use of existing rock pits is proposed under either action alternative.

Appendix F

Klamath National Forest
Sufficiency Standards for Geology

Appendix F
Klamath National Forest
Sufficiency Standards for Geology

DRAFT
Sufficiency Standards of Investigation for Geology

January 31, 2003 By: Juan de la Fuente

Background

Proper consideration of geologic hazards and resources is essential to the sound management of National Forest lands. On the Klamath National Forest, this is particularly true of assessing landslide and airborne asbestos risk, and evaluating potential rock resources and groundwater. Goals for geologic assessments are to assure that we:

1. Manage for Aquatic Conservation Strategy Objectives.
2. Protect water quality and quantity to meet State and Federal water quality standards, Forest Service policy and 2880 manual direction.
3. Protect public health, safety, welfare and property from geologic hazards on National Forest System Lands.
4. Protect geologic resources (minerals, groundwater, geothermal power, rock aggregate, Geologic Special Interest Areas, and caves) from being adversely affected by land management activities.
5. Develop geologic resources (groundwater, rock aggregate, mineral, oil, geothermal, unique geologic areas) are developed in an environmentally and economically sound manner.

Skills Required

A journeyman level (GS 9 or 11) geologist will provide an assessment of effects for all projects with the potential for producing adverse ecological effects or adverse effects on human life or property. This would apply to most projects involving road construction or maintenance, or disturbances to the soil or vegetation on sensitive lands. Though not required by law, it is highly recommended that the geologist be registered by the State of California.

Standards

The following standards for Geologic investigations are identified:

1. Identification of potential issues and proposed action with the ID team and responsible official, including project specific geologic hazards and resources.
2. Determination of, including field verification, of unstable lands in the vicinity of planned activities, utilizing appropriate methods for mapping unstable lands.

3. Development of project design standards including Best Management Practices and mitigation measures and project-level monitoring.

4. Analysis of the direct, indirect, and cumulative effects on aquatic resources for all alternatives. Assessments will describe how the project may negatively or positively affect important ecological features or processes as well as human life and property.

5. Documentation of work in a standardized Geologic Report, including map updates to unstable land Riparian Reserves. Also addressing how the action alternative meets ACS objectives.

6. Implementation of LRMP Geologic Standards and Guidelines.

Appendix G

NEPA Intensity Factors for Alternatives B and C on the Geologic Resource

Appendix G
NEPA Intensity Factors for
Alternatives B and C on the Geologic Resource

Intensity Factors	How Applicable to the Geologic Resource
Beneficial and adverse impacts	Emphasizes low impact harvest prescriptions; closure of roads; no significant impacts. Overall impact beneficial due to reduction of risk of stand-replacing wildfire.
The degree to which the proposed action affects public health	Low with implementation of measures to mitigate asbestos issue.
Unique characteristics of the geographic area	Potential cave resources more than one-quarter mile from proposed activities
The degree to which the effects on the human environment are likely to be highly controversial	Not likely.
The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks	Uncertainty always exists regarding predicting changes in slope hydrology associated with timber harvest.
The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration	Project removes scattered, smaller or intermediate sized trees from Riparian Reserve with long-term objective of improving stand health. Project adheres to guidance from Klamath LRMP and Northwest Forest Plan.
Whether the action is related to other actions with individually insignificant but cumulatively significant impacts	Other actions in the watershed were examined for CWE. Only anticipated actions are related to watershed improvement (e.g., stormproofing roads).
The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places, or may cause loss or destruction of significant scientific, cultural, or historical resources	Not relevant to geologic resources.
The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973	Not relevant to geologic resources.
Whether the action threatens a violation of Federal, State, or local law or other requirements imposed for the protection of the environment	No.

Direct and Indirect Effects by Management Activity

Timber Harvest Prescriptions

Thinning. Direct effects of this activity result in an increase in spacing between trees, small openings, and placing slash on the ground. Since trees are usually less than 30 inches in diameter, yarding disturbance due to dragging will likely be small. **Indirect effects** of thinning include a very small to negligible increase in landslide risk due to a small and short-term reduction in root support and evapotranspiration. In the longer term (10–20 years) stand health will improve as a result of removal of thinning of dense understory trees. In addition, potential for high intensity fire is reduced. These changes will reduce landslide potential.

Timber Yarding

Tractor Yarding. Tractor yarding involves the **direct effects** associated with tractor roads and end lining (physically disturbing the soil, and compaction), primarily on skid trails. **Indirect effects** can include increased landslide potential due to cuts, fills, or diverted water associated with tractor use. It is assumed that tractors would generally stay on ground no steeper than 35 percent, unstable areas would be avoided, no new full bench skid roads would be constructed, and water bars would be installed to avoid drainage diversions. With application of these measures, landslide potential will not increase.

Skyline Yarding. Skyline yarding would have **direct effects** of disturbing and displacing the soil and disturbance to residual vegetation in cable yarding corridors caused by dragging logs. The cable corridor can vary from 6 to 8 feet wide. Where logs cannot be adequately suspended, gouging can occur up to a foot in depth, depending on size and number of trees yarded. When water barred and covered with logging slash, erosion can be effectively mitigated. **Indirect effects** of cable yarding can include increased landslide potential associated with gouging of hillslopes, which can concentrate and surface runoff.

Asbestos Dust Associated With Yarding Activities. Timber yarding in areas underlain by ultramafic rock can have the **direct effect** of introducing asbestos fibers into the air during yarding activities. The potential is greatest with tractor yarding, which involves the most soil disturbance. No timber yarding is proposed in any alternative for this project.

Roads, Landings, and Rock Quarries

New Road Construction and Opening of Abandoned Roads. Direct effects include removal of vegetation, and disturbance to soils and slopes associated with road cuts, and fills. **Indirect effects** can include increased landslide potential where cuts are placed on unstable slopes, fills placed on steep slopes, or fills placed on deep-seated landslides. Landslide potential can also be increased by road-related changes in subsurface and surface flow. Landslide potential will be mitigated by avoidance of unstable lands, minimizing cuts and fills, and applying mitigation where subsurface water is encountered. Specific design measures will be developed during the implementation phase.

Road Closure. Direct effects of road closure include excavating fills, outsloping, excavations for landslide repair, re-filling of cuts, and local placement of rock in channels. **Indirect effects** of these actions include restoration of hydrologic patterns, elimination of the potential for fill failure, and reduction in the risk of cut bank failures. However, closure does not completely restore pre-road conditions.

Maintenance. Direct effects of road maintenance include disturbance of the road surface and ditches as well as culvert inlets and outlets where vegetation may be removed. **Indirect effects** include changes in surface drainage patterns, and increased efficiency of culvert flow.

Asbestos Hazard. Direct effects of road construction, maintenance, closure, or rocking in areas underlain by ultramafic rock include the potential for introducing asbestos fibers into the atmosphere. During road use, asbestos hazard can be mitigated by watering the road surface. During road construction the hazard can be mitigated by use of respirator equipment. Where unpaved roads traversing ultramafic rock intersect paved public roads, there is a potential for equipment to track soil and rock out on to the pavement where traffic on the highway can introduce dust into the air.

Landings. Direct effects of using existing landings include removal of vegetation that may have encroached since the last use and blading and shaping of the surface and adding rock. **Indirect effects**

of landings can include increased landslide potential downslope if runoff is concentrated, cuts placed in unstable slopes, or loose fill placed on steep slopes. Application of design standards can minimize landslide potential associated with landing use and maintenance.

Rock Quarry Development. Direct effects of quarry development can include removal of overburden, excavation of rock (with drilling and blasting if necessary) and generation of dust. Cuts and fills are created, and drainage patterns are changed. In ultramafic rock, this process can introduce asbestos into the air. Similarly, placement of such rock on road surfaces can also introduce asbestos fibers into the air. If not done properly, cuts and fills associated with development can have the **indirect effect** of increasing landslide risk. Similarly, placement of ultramafic rock on system road surfaces can have a long-term **indirect effect** by producing dust whenever dry-season traffic occurs on the road in the future.

Fuel Reduction

Hand piling. Direct effects include very minor surface disturbance, with local removal of vegetation and heating of the soil and deposition of ash where piles are burned. This practice can have very small indirect effects on surface runoff patterns due to local water repellency that can be caused by burning, and these **indirect effects** would not likely increase landslide potential.

Underburning. Underburning will occur in harvested areas and areas outside of harvest units. **Direct effects** include removal of organic material and addition of ash and removal of low vegetation. This practice has negligible adverse **indirect effects** on landsliding, provided high and moderate intensity burns are avoided.

Cumulative Effects

Cumulative effects are those that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. They can result from individually minor but collectively significant actions taking place over period of time (paraphrased from the Council on Environmental Quality (CEQ) guidelines 40 CFR 1508.7 Issued April 23, 1971). An example of a cumulative effect as related to landslides follows: Take the example of a completely forested subwatershed which experiences a small number of debris flows in headwaters in response to a storm with a 10-year return interval. A few small debris flows from tributary channels are usually not sufficient to initiate a debris flow in the main stream that could adversely affect fish habitat. However, if the same watershed were intensely roaded and de-forested at the time of the same 10 year storm, it might experience twice as many debris flows, and the cumulative effect of these small landslides would be much more likely to generate a debris flow in the main stem, with large adverse effects. In summary, the greater the disturbance in a watershed (roads, harvest, fire), the greater the potential for adverse CWEs.

Appendix H

Site-Specific Best Management Practices

Appendix H
Site-Specific Best Management Practices

UNIT	STAND	BMP IMPLEMENTATION NOTES
M Unit 3	751	Implement BMPs to normal standards. No special features present.
M Unit 4	752	Implement BMPs to normal standards. No special features present.
M Unit 7N	773	Implement BMPs to normal standards. No special features present.
M Unit 7S	755	Implement BMPs to normal standards. No special features present.
M Unit 8	756	Implement BMPs to normal standards. No special features present.
M Unit 9	502	Implement BMPs to normal standards. No special features present.
M Unit 10	757	BMP 1.9—Refine limits of tractor ground during unit layout. BMP 1.10—Mulch or slash any skid trails on slopes over 35%.
M Unit 11	758	Implement BMPs to normal standards. No special features present.
M Unit 12	509	Implement BMPs to normal standards. No special features present.
M Unit 13	303	Implement BMPs to normal standards. No special features present.
M Unit 15	701	BMP 1.6—Retain 40% canopy closure in vigorous trees for rooting strength and transpiration of subsurface water. BMP 1.11—Layout cable corridors to maximize log suspension and minimize surface disturbance to small areas of wet soil scattered through unit. BMP 1.14—Scatter slash to 80% ground cover on any wet areas disturbed by yarding. BMP 1.9—Refine limits of tractor ground during unit layout.
M Unit 16	702	BMP 1.8—Hold unit boundary on northeast back from intermittent channel 170 feet.
M Unit 17	703	BMP 1.9—Refine limits of tractor ground during unit layout. BMP 1.10—Mulch or slash any skid trails on slopes over 35%. BMP 2.6—Correct road drainage problems at bottom of unit along 39N20.
M Unit 19	705	BMP 1.8—Riparian Reserves (RR) designated in lower portion of center-most draw. Hold unit boundary above 4240 contour to avoid incursion into RR.
M Unit 20	706	Implement BMPs to normal standards. No special features present.
M Unit 21	707	BMP 1.8—Establish 50 foot equipment exclusion streamside management zone (SMZ) along draw in southwest corner of unit below 39N73.
M Unit 22	801	Implement BMPs to normal standards. No special features present.
M Unit 23	802	BMP 1.6—Small soil slips (very small and shallow) observed in unit. Slopes up to 80%. Thin conservatively to retain necessary rooting mass to reinforce soil.
M Unit 24	803	BMP 1.8—Hold unit boundary back from RR on south boundary or establish 170 foot SMZ—equipment exclusion, 80% ground cover retention, 60% canopy retention.
M Unit 25	804	BMP 1.11—Layout cable corridors to maximize log suspension and minimize surface disturbance to small areas of wet soil scattered through unit. BMP 1.14—Scatter slash to 80% ground cover on any wet areas disturbed by yarding. BMP 1.9—Refine limits of tractor ground during unit layout.
M Unit 30	553	Implement BMPs to normal standards. No special features present.
M Unit 31	351	BMP 1.9—Refine limits of tractor ground during unit layout. BMP 1.10—Mulch or slash any skid trails on slopes over 35%.
M Unit 32	552	Implement BMPs to normal standards. No special features present.
M Unit 35	805	BMP 1.6—Retain 40% canopy closure in vigorous trees for rooting strength and transpiration of subsurface water. BMP 1.11—Layout cable corridors to maximize log suspension and minimize surface disturbance to small areas of wet soil scattered through unit. BMP 1.14—Scatter slash to 80% ground cover on any wet areas disturbed by yarding. BMP 1.9—Refine limits of tractor ground during unit layout.
M Unit 36	806	Implement BMPs to normal standards. No special features present.
M Unit 37	708	BMP 1.9—Refine limits of tractor ground during unit layout. BMP 1.10—Mulch or slash any skid trails on slopes over 35%.
M Unit 38	709	Implement BMPs to normal standards. No special features present.
M Unit 39	759	Implement BMPs to normal standards. No special features present.
M Unit 40	761	Implement BMPs to normal standards. No special features present.

UNIT	STAND	BMP IMPLEMENTATION NOTES
M Unit 43	762	Implement BMPs to normal standards. No special features present.
M Unit 51	554	Implement BMPs to normal standards. No special features present.
M Unit 52	710	Implement BMPs to normal standards. No special features present.
M Unit 54	712	Implement BMPs to normal standards. No special features present.
M Unit 55	763	Implement BMPs to normal standards. No special features present.
M Unit 60	807	Implement BMPs to normal standards. No special features present.
M Unit 61	808	BMP 1.6—Unit located just below old earthflow. Timber Sale Administrator (TSA) to consult earth scientist if active instability is encountered during layout. BMP 1.8—Spring fed draws border unit. Establish 50 foot equipment exclusion zone measured from edge of saturated soil.
M Unit 65	764	BMP 1.8—Intermittent channel borders unit on the northeast. 50 feet equipment exclusion zone.
M Unit 66	765	Implement BMPs to normal standards. No special features present.
M Unit 69	768	BMP 1.8—Intermittent channel borders unit on the north end. 50 feet equipment exclusion zone. Maintain minimum 80% ground cover.
M Unit 73	306	Implement BMPs to normal standards. No special features present.
M Unit 75	505	BMP 1.11—Full log suspension 50 feet each side of centerline of intermittent draws running through unit.
M Unit 76	506	Implement BMPs to normal standards. No special features present.
M Unit 79	307	Implement BMPs to normal standards. No special features present.
M Unit 80	772	Implement BMPs to normal standards. No special features present.
RS1	300	Implement BMPs to normal standards. No special features present.
RS2	300	BMP 1.9—Limit masticator to slopes less than 45%.
RS3	300	BMP 1.8—Maintain 70% ground cover and 70% shade canopy in RRs (170 foot width). 50 foot exclusion zone for masticator. BMP 1.9—Limit mastication to slopes less than 45%.
FRZ 2		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 3		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 4		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 5		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 6		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 7		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 9		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 10		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 11		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 12		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 13		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 14		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 15		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 16		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.

UNIT	STAND	BMP IMPLEMENTATION NOTES
FRZ 17		BMP 1.6—Active landslide mapped below 39N59 just north of unit M15. High subsurface moisture. Keep masticator off wet ground that might otherwise be suitable based on slope (see GEO13 map). BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
FRZ 20		BMP 1.9—Limit masticator to slopes less than 45%. BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 1		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 2		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 3		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 4		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 5		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 6		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 7		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 8		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 9		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 11		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.
Rx Unit 12		BMP 6.2–BMP 6.3—Waterbar and scatter slash on any fire lines constructed in RRs.

Appendix I

Naturally Occurring Asbestos in Eddy Gulch LSR Project

Naturally Occurring Asbestos in Eddy Gulch LSR Project

Prepared by: Angie Bell, Geologist, Klamath National Forest
26 September 2009

Naturally Occurring Asbestos (NOA) is a suite of fibrous, silicate minerals that are commonly associated with ultramafic rock, including serpentinite. Asbestos can pose a health hazard if it is released as dust into the air and inhaled by a human. Asbestos exposure has been associated with several forms of diseases. Ultramafic bedrock, including serpentinite, is a common host for local deposits of NOA (Van Gosen 2007) and the most likely source of NOA on the Klamath National Forest. NOA is not a potential health hazard until it is disturbed and enters the air, where it can be inhaled. The disturbance of ultramafic rock can release dust, potentially containing NOA. Ultramafic rock is present in the southwestern corner of the Eddy Gulch LSR Project assessment area.

Methods

Two roads (38N27 & 39N23) through ultramafic rock were analyzed for NOA in the Eddy Gulch LSR project area. The samples were collected between 23 April 2009 and 5 May 2009 by Curtis Hughes (Klamath National Forest Minerals Officer). As suggested by the California Air Resource Board, three samples from the top 1-2 inches of the roadway were randomly taken for each mile of road within the ultramafic body. If the segment of road to be analyzed was less than one mile three samples were still taken.

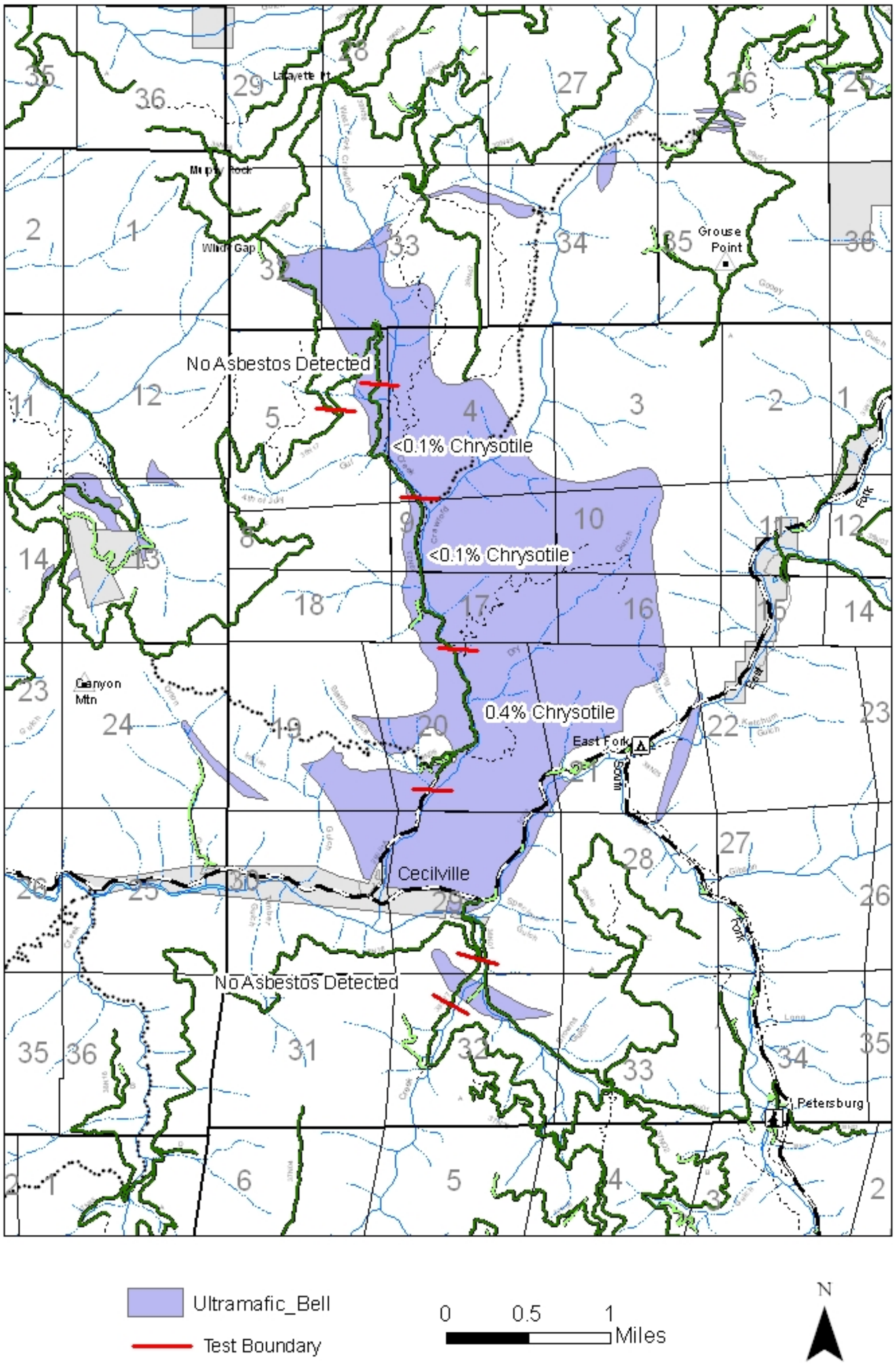
Each of the three samples from a given mile of road were combined in the same container and mixed. The composite sample was sent to the laboratory for analysis. AmeriSci –Los Angeles Laboratory performed the CARB Method 435 analysis for NOA on bulk samples (California Air Resource Board 1991). It entails a polarized light microscopic technique to identify the asbestiform material and perform a point count on samples to determine the mineralology and percent of any asbestos in the sample. The detection level of this analysis technique is 0.1%.

Results and Discussion

The results are outlined in Figure 1. FS 39N23 has a concentration of 0.4% chrysotile asbestos and then gradually reduces to levels below the detection limit of the analysis (0.1%). The surface material for FS 38N27 did not contain any detectable NAO.

There is NOA present on the roadways in the project area. The most stringent California Air Resource Board suggestion for NOA on roadways is that the surface material must contain less than 0.25% NOA (CARB, 2002a). Aside from the first mile of FS 39N23, the NOA concentration is within the California Air Resource Board guidelines. The most likely cause for high concentrations of dust to be released during the implementation of this project is traveling on the roadways. Therefore, dust control measures such as watering or rocking the roadways will mitigate and minimize the health risks from the presents of NOA on the roadways (CARB 2002b).

Figure 1. Results of testing of road material using CARB method 435.



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