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Geology Report

Westside Fire Recover project

Happy Camp/Oak Knoll and Salmon/Scott River Ranger Districts
Klamath National Forest
Siskiyou County, CA

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Executive Summary

Methodology

Three days of field review were completed to validate geologic and geomorphic mapping. Unstable lands are designated as Riparian Reserves in the Forest Plan (Standard and Guideline MA 10-2, pg. 4-108). The unstable lands component of Riparian Reserves includes active landslides, inner gorges, toe zones of dormant landslides and severely weathered and dissected granitic lands. List of actions considered for cumulative effects in appendix C (map project record). This analysis assumes that if less than 1 percent of the 7th field watershed is in the project boundary there will be no effect to landslide risk. So only the sixty-seven watersheds with greater than one percent of their area in the project boundary are analyzed (see appendix B of the Geology resource report for list of watersheds analyzed).

The Cumulative Watershed Effects GEO model is used to estimate the landslide potential. The model uses mapping of the geomorphology, past and present disturbances, and coefficients developed using research on the effects of the 1964 flood event on landslide rates. The output from the model is volume of sediment delivered to the mouth of the 7th field watershed during a 10-year storm event (cubic yards per decade). The volumes are converted into a risk ratio to estimate landslide potential across the Forest and among project alternatives. A threshold of concern for the risk ratio is 1.0. This is not the point at which significant effects occur but a yellow flag indicating that additional impacts need to be considered closely for resource degradation and impacts to beneficial uses of water. Mitigations to prevent unacceptable negative impacts will be considered for watersheds with proposed activities that are over the threshold of concern. A more detailed description of the cumulative watershed effects modeling process is available in a Forest-wide document (Bell, 2012).

The indicator used in this analysis for effects on unstable lands is landslide risk. Risk is the intersection between the potential of landsliding and the consequence of landsliding. Landslide potential is estimated from the GEO model risk ratio. Consequences analyzed include: 1) impacts to human health and safety; 2) impacts to infrastructure; and 3) impacts to natural resources. Landslide risk ranges from very high, which indicates an immediate need for mitigation of the risk, to very low, which indicates a nuisance disruption. See appendix A of the Geology resource report for details.

The long-term elevated risk of landslide in a 7th field watershed is related to tree root support. Areas with compromised root support (due to fire or forest management) have about 6.5 times higher landslide rate than areas with intact roots (Amarathus et al. 1985). After trees die the root support begins to decline immediately and provide almost no support after about a decade. Duration of elevated risk is analyzed using the state of vegetation in a 7th field watershed. The measure of duration of elevated risk will be the percent of the watershed with moderate or high severity wildfire left to naturally regenerate (or left unplanted). So, if more than 75 percent of the high and moderate vegetation burn severity is left to naturally regenerate the duration of elevated risk in the watershed is assumed to be greater than 80 years. If the percent left unplanted in a watershed is less than 75 percent, it will be assumed that the duration of elevated risk is about 30 years. If less than 10 percent of the watershed was burned with high or moderate vegetation burn severity the elevated risk is assumed to be acute and will recover in two to five years.

Spatial and Temporal Context

The spatial scale for the landslide risk and cumulative effects analysis is the 7th field watershed because the models used for analysis are calibrated at the 7th field scale. The temporal scale is from the present to ten years for short-term and 10 to 50 years for long-term. Elevated landslide rates due to forest management in Northern California have been shown to begin to decrease around 7 to 12 years after a disturbance and recover in about 50 years (Ziemer 1981).

Affected Environment

The Beaver portion of the project area is mainly underlain by Condrey Mountain Schist bedrock. The schist contains graphite (which is commonly used as a lubricant) which makes the area susceptible to large scale deep-seated landslides. The large dormant landslide deposits in the Beaver fire area are due to a combination of the graphitic schist and past climatic and seismic activity (more than 1,000 years ago). There are small portions of dormant landslide deposits that have experienced active landsliding in recent history (less than 100 years).

The Happy Camp portion of the project area has three distinct geologic types. The Elk Creek area is primarily metasedimentary and metavolcanic bedrock. These areas have few landslides and the primary landslide mechanism is debris flow of sediment stored in the stream channels. There are areas of ultramafic rock that have small dormant landslides but few have active landslides within them. The Grider/Walker Creek area is underlain by highly weathered and dissected granitic lands. The watersheds are susceptible to shallow landsliding such as debris slides and debris flows. The Tompkins Creek area is underlain by a mosaic of bedrocks including ultramafic, granitic and metasedimentary bedrock. The actual landslide rate is low with only a handful of active landslides in the area.

The Whites portion of the project area is mainly underlain by metasedimentary and metavolcanic bedrock. These rocks are ancient ocean floor and tend to be fairly stable (low landslide potential). The headwaters of Music Creek and Taylor Creek are underlain by granitic bedrock which has been highly weathered. This led to the development of highly weathered and dissected granitic lands, susceptible to shallow landsliding such as debris slides and debris flows.

Of the sixty-seven 7th field watersheds analyzed for this project, three currently have a very high landslide risk. These are Rancheria Creek, Walker Creek and Lower Grider Creek. The likelihood that a landslide event will occur in Lower Grider and Walker Creek is almost certain and highly likely in Rancheria Creek. These three watersheds have a catastrophic consequence if a landslide (specifically a debris flow) occurs due to the proximity to the creek of private property with residential structures. There are twenty watersheds with a high landslide risk mainly due to the susceptibility of municipal water supplies, fish habitat and access to landslide events. Thirty of the watersheds analyzed have a moderate landslide risk and twelve have a low landslide risk.

There are forty 7th field watersheds that have more than 10 percent high or moderate vegetation burn severity. These watersheds will have an elevated landslide risk of greater than 80 years. These include Rancheria Creek, Lower Grider Creek, and Walker Creek which have very high landslide risks and thirteen of the watersheds with high landslide risks. The other twenty seven watersheds are assumed to have acute elevated landslide risk that will last about two to five years. Maps of the geomorphology and bedrock are in the Geology resource report on the project website.

Environmental Consequences

Alternative 1

Direct Effects and Indirect Effects

There are no direct effects to landslide risk under this alternative. The area will recover naturally including the re-establishment of vegetation and ground-cover, increasing root support and intercepting precipitation which reduces landslide risk and potential. However, prolonged hardwood and brush dominated occupancy will not provide the root support to maintain stable slopes (Jackson and Roering 2009**)**. The landslide risk will remain the same as current conditions for about 10 to 12 years (Zeimer 1981) and slowly begin to reduce as conifer forest begins to be established. The project area may take up to 80 years to recover to a pre-fire landslide risk level. It could take longer in areas where seed sources have been eliminated due to large pockets of high and moderate severity vegetation burn such as Walker, Grider and O'Neil Creek.

Cumulative Effects

The projects added to the effects of the past actions (the affected environment) and the direct and indirect effects of the project are portions of the Jess project, Scott Bar Underburn, Lovers Canyon, McCollins and Sawyers Bar Fuels Reduction Project that are in the 7th field watersheds analyzed. The Jess project and Lovers Canyon project are the only two future projects that have any effect on the risk ratio or percent watershed with high or moderate disturbance. Jess project increases the risk ratio for 0.01 and 0.07 for the Eddy Gulch and Jessups Gulch respectively. The Jess project increases the percent of the watershed with high and moderate disturbance by 1.5 percent for both watersheds. Lovers Canyon increases the risk ratios for South Fork Kelsey and Middle Creek by 0.03 and 0.02 respectively, and the percent disturbed is increased by 3.3 percent for both watersheds. The landslide risks are not increased by the addition of the effects of these projects. None of the projects affect the duration of elevated risk in the watersheds.

Alternative 2

Direct Effects and Indirect Effects

There are about 3,920 acres of salvage units (about 2,000 acres of salvage logging) on steep, weathered granitic lands (Riparian Reserve) proposed in this alternative. No salvage will occur on inner gorges, active landslides or toe zones of dormant landslides (see chapter 2 for project design features). Also proposed are about 960 acres of site preparation and planting, 4,395 acres of roadside hazard tree removal and 3,940 acres of fuels treatments on unstable lands considered to be Riparian Reserves.

Alternative 2 does not change the landslide risk for any watershed. There is a change in the risk ratio or the percent of watersheds with high or moderate disturbance for twenty-eight watersheds due to treatments. The average change in risk ratio is 0.01 and the maximum change was 0.11. The average change in percent of the watershed with high and moderate disturbance is 0.24 percent and the maximum change is 1.1 percent.

There is a reduction in the duration of elevated risk due to planting for nine watersheds compared to alternative 1. The 7th field watersheds with a high landslide risk that will have a reduced duration of elevated risk are Upper Grider Creek, Cliff Valley, Lower Grider Creek, O'Neil Creek, Walker Creek, and Caroline Creek. The reduction in duration of elevated risk will benefit natural resources and infrastructure in the long-term. Middle Creek, Horse Creek, and Upper Elk Creek have a moderate landslide risk and will have a duration of elevated risk of 30 years in this alternative. Lower Grider and Walker Creek have very high landslide risk due to the potential to impact private land – so the reduction of elevated risk from more than 80 years to 30 years is of great benefit for protecting human safety and private property in these two watersheds. Rancheria Creek, which also has a very high landslide risk, will continue to have a greater than 80-year duration of elevated risk because there is less than 25 percent of the high and moderate vegetation burn severity areas being planted. All other watersheds will have a greater than 80 year duration of elevated risk.

Cumulative Effects

The projects added to the effects of the past actions (the affected environment) and the direct and indirect effects of the alternative are portions of the Jess project, Salmon Reforestation, Scott Bar Underburn, Lovers Canyon, McCollins and Sawyers Bar Fuels Reduction Project that are in the 7th field watersheds analyzed. The Jess project and Lovers Canyon project are the only two future projects that have any effect on the risk ratio or percent watershed with high or moderate disturbance. Jess project increases the risk ratio for 0.01 and 0.07 for the Eddy Gulch and Jessups Gulch respectively. The Jess project increases the percent of the watershed with high and moderate disturbance by 1.5 percent for both watersheds. Lovers Canyon increases the risk ratios for South Fork Kelsey and Middle Creek by 0.03 and 0.02 respectively and the percent disturbed is increased by 3.3 percent for both watersheds. The landslide risks are not increased for any 7th field watershed by the addition of the effects of these projects. None of the projects affect the duration of elevated risk in the watersheds.

Alternative 3

Direct Effects and Indirect Effects

There are about 3,750 acres of salvage units (about 1,900 acres of salvage logging) on steep, weathered granitic lands (Riparian Reserve) proposed in this alternative. No salvage will occur on inner gorges, active landslides or toe zones of dormant landslides (see chapter 2 for project design features). Also proposed are about 960 acres of site preparation and planting, 4,395 acres of roadside hazard tree removal and 3,940 acres of fuels treatments on unstable lands considered to be Riparian Reserves.

The indirect effects to the landslide risk are the same as for alternative 2. The duration of elevated risk will not be reduced in Horse Creek, because the percent of the 7th field planted drops below 25 percent. All other durations of elevated risk will remain the same as alternative 2.

Cumulative Effects

The cumulative effects are the same as for Alterntive 2.

Alternative 4

Direct Effects and Indirect Effects

There are about 3,740 acres of salvage units (about 1,900 acres of salvage logging) on steep, weathered granitic lands (Riparian Reserve) proposed in this alternative. No salvage will occur on inner gorges, active landslides or toe zones of dormant landslides (see chapter 2 for project design features). Also proposed are about 960 acres of site preparation and planting, 4,290 acres of roadside hazard tree removal and 3,940 acres of fuels treatments on unstable lands considered to be Riparian Reserves.

The indirect effects to landslide risk are the same as for alternative 2. There are only five 7th field watersheds that have a reduction in the duration of elevated risk. Lower Grider will have an elevated risk for more than 80 years under this alternative compared to 30 years in alternative 2. Upper Grider Creek, Horse Creek, and Upper Elk will have an elevated risk for more than 80 years compared to 30 years under alternative 2. All other durations of elevated risk are the same as alternative 2.

Cumulative Effects

The cumulative effects are the same as for Alternative 2.

Alternative 5

Direct Effects and Indirect Effects

There are about 465 acres of salvage units (about 250 acres of salvage logging) on steep, weathered granitic lands (Riparian Reserve) proposed in this alternative. No salvage will occur on inner gorges, active landslides or toe zones of dormant landslides (see chapter 2 for project design features). Also proposed are about 960 acres of site preparation and planting, 4,395 acres of roadside hazard tree removal and 3,970 acres of fuels treatments on unstable lands considered to be Riparian Reserves.

The indirect effects for landslide risk are the same as for alternative 2. The duration of elevated risk is the same as for alternative 4.

Cumulative Effects

The cumulative effects are the same as for Alternative 2.

Compliance with law, regulation, policy, and the Forest Plan

The project is compliant with the Klamath National Forest Plan (1995, as amended) Standards and Guidelines. A geologic investigation was completed and natural regeneration of vegetation on unstable lands will improve slope stability in portions of the project area but recovery could take between 30 and 80 years.

Geology Report

Introduction

The purpose of this report is to evaluate the effects of the Westside Fire Recovery project on landslide processes.

Methodology

Ten days of field review were completed to validate geologic and geomorphic mapping in the project area. Unstable lands are designated as Riparian Reserves in the Forest Plan (Standard and Guideline MA 10-2, page 4-108). The unstable lands component of Riparian Reserves includes active landslides, inner gorges, toe zones of dormant landslides and severely weathered and dissected granitic lands (Forest Plan, page 4-18). See Figure 2, Figure 4, and Figure 6 in Appendix A for location of unstable lands in the project area. This analysis assumes that if less than 1% of the 7th field watershed is in the project boundary there will be no effect to landslide risk. So only the sixty-seven watersheds with greater than 1% of their area in the project boundary are analyzed (see Appendix B for list of watersheds analyzed).

The Cumulative Watershed Effects (CWE) GEO model is used to estimate the volume of landslide events and the risk ratio. The model uses mapping of the geomorphology, past and present disturbances, and coefficients developed using research on the effects of the 1964 flood event on landslide rates. The output from the model is volume of sediment delivered to the mouth of the 7th field watershed during a 10-year storm event (cubic yards per decade). The volumes are converted into a risk ratio to estimate landslide potential across the Forest and among project alternatives. A more detailed description of the cumulative watershed effects modeling process is available in a Forest-wide document (Bell 2013)**.** The CWE models were only ran for the current condition and alternative 2. The risk ratios for alternative 2 are increased in seventeen of the sixty-seven 7th field watersheds analyzed and all the increases were less than 0.11 (Table 4). Alternative 2 is the most impactive to watershed processes and it is assumed that all other alternatives would have similar results.

Information from the geographic information system (GIS) was used to estimate the number of acres of a watershed with high and moderate disturbances in the past 10 years. The analysis gave precedence to the most recent activity; or most of the watersheds, this was the 2014 wildfires. However, if an activity with a high or moderate disturbance occurred in the watershed that was not overprinted by recent wildfire activity, it was included in the calculation of percent disturbance used in the likelihood factor described below.

Analysis Indicators

Landslide Risk

The forest-wide goal is to promote slope stability and maintain soil productivity on geologically unstable lands (Forest Plan, page 4-5). Slope stability is indirectly affected by many land management practices. However, it is difficult to directly measure slope stability due to the stochastic (random) and complex nature of landslide processes in the Klamath Mountains. This analysis uses landslide risk as a proxy for slope stability. Landslide risk is a combination of the likelihood a landslide event may occur and the consequences of such an event.

Landsliding Likelihood

Landslide likelihood is determined by geomorphic landform, disturbance, vegetation condition, bedrock type, and groundwater conditions. The analysis uses existing geomorphic mapping, bedrock mapping and historical landslide information to determine the likelihood of landsliding. A majority of the west side of the Forest is relatively unstable so the likelihood of having small localized landslides in any given 7th field watershed during any storm is highly probable. This analysis is focused on determining the likelihood of a *landslide event*. A landslide event is defined for this analysis as large-scale, extensive episode resulting in several landslides that could interrupt ingress/egress, fluvial processes on 3th to 5th order streams or damage major infrastructure across a 7th field watershed. (Dai et al 2002, Wise et al 2004 and AGS 2007)

The likelihood of a landsliding event was analyzed at the 7th field watershed scale using a combination of the percent of headwaters (0th to 1st order streams on the upper 1/3 of slope) harvested or burned within the last 10 years, CWE GEO risk ratio, percent of unstable lands and the road density. The likelihood categories are summarized below:

1) Almost Certain – a landsliding event is expected to occur even under an average storm event (2-year storm event). A watershed in this category meets at least **two** of the following criteria: 1) greater than or equal to 25% of the watershed had high to moderate disturbance (based on soil burn severity, silviculture or fuels reduction prescriptions) in the past 10 years; 2) CWE GEO risk ratio greater than or equal to 1.5; or 3) greater than or equal to 25% of area designated as unstable lands (per definition in Forest Plan)
2) Highly Likely – A landsliding event will probably occur under an average storm event. A watershed in this category meets at least **one** of the following criteria: 1) greater than or equal to 25% of the watershed had high to moderate disturbance (based on soil burn severity, silviculture or fuels reduction prescriptions) in the past 10 years; 2) CWE GEO risk ratio is greater than 0.95; or 3) greater than or equal to 25% of the area is designated as unstable lands.
3) Likely – A landsliding event is likely to occur under a 10- to 20-year storm event. A watershed in this category meets at least **one** of the following criteria: 1) between 10% and 25% of the watershed had high to moderate severity disturbance (based on soil burn severity, silviculture or fuels reduction prescriptions) in the past 10 years; 2) CWE GEO risk ratio is between 0.75 and 0.95; or 3) between 10% and 25% of the area is designated as unstable lands.
4) Unlikely – Landsliding might occur under a 20- to 99-year storm event. A watershed in this category meets if it is on the west side of the Forest and does not meet the criteria in above categories.
5) Rare – Landsliding is conceivable but only under a ≥100-year storm event. A watershed meets this category if it is on the east side of the Forest (with occasional exceptions).

High and moderate disturbance for this project includes areas defined to have:

- High and moderate soil burn severity;
- Removal of greater than 50% live tree basal area;
- Construction new temporary roads (assumed 25 feet disturbance width);

- Opening of temporary roads on existing roadbeds (assumed 16 feet disturbance width);
- Reopening of decommissioned roads (assumed 16 feet disturbance width); and
- Construction of new landings (assumed 1.5 acre disturbance).

Salvage logging or removal of fire-killed trees is not included in high and moderate disturbance for landslide risk. The removal of fire-killed trees is not likely to cause measurable changes in hillslope hydrology as these trees no longer transpire or intercept precipitation (Jackson & Roering, 2009). In the long term, reduction of snags will result in a reduction in down large wood on hillslopes. This will have some potential for increasing surface erosion but will also result in less water infiltrating into the hillslope due to the interception effect of the logs, and groundwater is an important trigger for landsliding. However, slash from salvage logging will enhance infiltration of water into soils but at the same time, protect soils from rilling, gullying, and shallow landslides.

Consequence Categories

The consequences of a landslide are based on the impacts to elements at risk. The elements at risk for this analysis are human safety, infrastructure, property, recreation/visitor use and environmental resources. The consequences categories are summarized below:

1) Catastrophic Consequences– In this category human health and safety is susceptible to landslide events. The presence of occupied structures (homes, businesses, work areas), campgrounds, or heavily used roads that are vulnerable to (in the path of) a potential landslide event meets the criteria for this category.
2) Major Consequences – In this category essential infrastructure such as main National Forest Transportation System (system) roads (maintenance levels 3, 4 and 5), power lines, pipelines, municipal water sources, and railroads is susceptible to (in the path of) landslide events and may be rendered inoperative as a result. The category also is used to describe vulnerability of anadromous fish habitat to landslide events that lead to the complete loss of the habitat. This category also applies when stream channels are vulnerable to landsliding which leads to aggrading (depositing sediment) or degrading (removing sediment) the stream channel. Also, the reduction of shade and riparian vegetation over a large portion of late flowing intermittent or perennial streams is a major consequence.
3) Moderate Consequences – In this category only non-essential infrastructure and property such campgrounds (unoccupied), trailheads, day use areas and system trails are vulnerable to landslide events and will be rendered inoperable. Landsliding debris will temporarily block major ingress/egress roadways. Anadromous fish habitat is vulnerable to a partial loss or short-term impairment. This category also applies when stream channels are vulnerable to aggradation, degradation or a reduction shade over a small portion of late-flowing intermittent and perennial streams.
4) Minor Consequences – In this category infrastructure is vulnerable to damage that does not render it inoperable but makes its operation unsafe or inconvenient (e.g. debris partially blocking a two-lane road) as a result of landslide events. The minor damage category applies to landsliding into streams that are vulnerable to a reduction of shade at the site scale or blocking the stream for the short term (<6 months).

5) Nuisance Consequences – In this category there is no infrastructure, fish habitat or stream shade vulnerable to landslide events.

Landslide Risk Matrix

The landslide risk matrix (Table 1) is the cross-walk between the likelihood and consequences and the implications for Forest management. Once the likelihood and consequences have been determined using the criteria above, the risk matrix is used to determine the risk category that fits that situation. For instance, you may have an area that is likely to experience landsliding during a 10-year storm event and the essential infrastructure vulnerable to landsliding. In this case the landslide risk is high. This risk has implications for Forest management which are described in the section below.

Table 1: Risk matrix using likelihood and consequence to assess risk of a landslide event in a 7th field watershed.

Consequences/Likelihood	Almost Certain	Highly likely	Likely	Unlikely	Rare
Catastrophic Consequences	Very High	Very High	High	Moderate	Moderate
Major Consequences	Very High	High	High	Moderate	Low
Moderate Consequences	High	High	Moderate	Moderate	Very Low
Minor Consequences	High	Moderate	Low	Low	Very Low
Nuisance Consequences	Low	Low	Very Low	Very Low	Very Low

The Risk Category Implications

- Very High – Health and human safety or essential infrastructure is at risk. There is an immediate and urgent need to reduce the likelihood of landsliding or mitigate the consequence to the elements at risk.
- High – There is a reasonable probability that landsliding will impact essential infrastructure and may impact health and human safety. Non-essential infrastructure as well as recreation and visitor use may be impacted. Project-wide and global mitigations need to be in place to minimize impacts to landslide processes for actions in these watersheds.
- Moderate - There is a moderate probability of impacts to essential or non-essential infrastructure or health and human safety as a result of landsliding. The cost and benefit of mitigations needs to be considered before actions are proposed for implementation. Strategic or localized mitigations need to be in place to minimize impacts to landslide processes for actions in these watersheds.
- Low – There a low probability of impacts to elements at risk. Remediation of landsliding consequences may be the most cost effective method of dealing with these areas.
- Very Low – There is almost no probability of impacts to elements at risk as a result of landsliding. Mitigations are rarely needed.

Duration of Elevated Landslide Risk

Wildfire events have an effect on several landslide processes that elevate the landslide likelihood in a watershed. The effects can be relatively acute and short-term or chronic and long-term. The acute effects include excess sediment building up in the channel from increased soil erosion for the first year post-fire (Parise and Cannon 2012; Swanson 1981). The reduction in evapotranspiration in watersheds from trees that were fire killed can also increase soil water pore pressure (water between the grains of soil). The soil water pore pressure can remain elevated (Parise and Cannon 2012) for the first few years post-fire, until shrubs and hardwoods are re-established. In the meantime, the elevated soil water pore pressure will create less friction in the soil, increasing the likelihood of landslide events (Parise and Cannon 2012; Shakesby and Doerr 2006; Swanson 1981). The effects of the fire on these geomorphic processes diminish naturally in about 2-3 years after the fire.

The long-term effects to landslide processes are related to the large-scale loss of forest vegetation due to the wildfire event. In the Klamath Mountains, areas that have been deforested have about a 6.5 times higher landslide rate than areas with intact forest vegetation (Amarathus et al 1985). The roots of forest vegetation, especially trees, help stabilize slopes by providing additional strength to the soil (Ziemer 1981; Ziemer and Swanston 1977; Ammann et al. 2009). Once trees are killed, even their largest roots start to decay and lose strength within a decade (Ziemer and Swanston 1977). In the Klamath Mountains, about half of reinforcement from tree roots is lost within 2-3 years of death and nearly three-fourths of the strength is gone within 8 years. The roots provide almost no soil strength 25 years after the trees die (Ziemer 1981). Brush provides some soil strength but, at best, provides 60 percent of the soil strength of an intact conifer forest (Ziemer 1981). Once a conifer forest becomes established, the soil strength from root-support increases quickly and levels out after about 20 years (Abe and Ziemer 1991). So, the most important factor in the duration of the elevated landslide risk due to wildfire is the length of time it takes to get conifer forests re-established on hillslopes.

In scientific literature, the connection between root strength and landslide rate is at the site scale, not the watershed scale. Therefore, the following assumptions have to be made for this analysis:

1) The main driver for an elevated landslide risk for watersheds with greater than 10% high and moderate vegetation burn severity;
2) The relationship between root support and landslides is the same at all scales;
3) The loss of root support is cumulative throughout the watershed;
4) Areas burned with low or very low vegetation severity or those outside of the fire perimeter generally have sufficient root strength to retain slope stability. Areas that have undergone green tree regeneration harvest in the last 10 years are an exception to this assumption. In areas burned with moderate or high vegetation mortality that are left to naturally regenerate, the re-establishment of forest with an average diameter of 10 inches will take more than 80 years. Areas that have been artificially regenerated will have a re-established of forest with an average diameter of 10 inches in about 30 years; and
5) The duration of elevated risk is based on the state of vegetation on a majority of the watershed.

The measure of duration of elevated risk will be the percent of the watershed with moderate or high severity wildfire left to naturally regenerate (or left unplanted). So, if more than 75% of the

high and moderate vegetation burn severity is left to naturally regenerate the duration of elevated risk in the watershed is assumed to be greater than 80 years. If the percent left unplanted in a watershed is less than 75%, it will be assumed that the duration of elevated risk is 30 years. If less than 10% of the watershed was burned with high or moderate vegetation burn severity the elevated risk is assumed to be acute and will recover in 2-5 years.

Spatial and Temporal Bounding of Analysis Area

The spatial scale for analysis is the 7th field watershed scale for the direct/indirect effects and the cumulative effects. The models used for analysis are calibrated at a 7th field scale (Bell 2012). The temporal scale is 0 to 10 years for short-term and more than10 years for long-term. Elevated landslide rates due to forest management have been shown to begin to decrease around 7 to 12 years after the disturbance in Northern California (Ziemer 1981).

Affected Environment

The Beaver portion of the project area is mainly underlain by Condrey Mountain Schist bedrock (see Figure 1 in Appendix A). The schist contains graphite (which is commonly used as a lubricant) which makes the area susceptible to large scale deep-seated landslides (Figure 2 in Appendix A). The large dormant landslide deposits in the Beaver fire area are due to a combination of the graphitic schist and past climatic and seismic activity (more than 1,000 years ago). There are small portions of dormant landslide deposits that have experienced active landsliding in recent history (less than 100 years). These are mapped and shown in Figure 2 (Appendix A).

The Happy Camp portion of the project area has three distinct geologic types. The Elk Creek area is primarily metasedimentary and metavolcanic bedrock (Figure 3 in Appendix A). These areas have few landslides and the primary landslide mechanism is debris flow of sediment stored in the stream channels. There are areas of ultramafic rock that have small dormant landslides but few have active landslides within them (Figure 4). The Grider/Walker Creek area is underlain by highly weathered and dissected granitic lands. The watersheds are susceptible to shallow landsliding such as debris slides and debris flows. The Tompkins Creek area is underlain by a mosaic of bedrocks including ultramafic, granitic and metasedimentary bedrock (Figure 3 in Appendix A). The landslide rate is low with only a handful of active landslides in the area (Figure 4 in Appendix A).

The Whites portion of the project area is mainly underlain by metasedimentary and metavolcanic bedrock (Figure 5 in Appendix A). These rocks are ancient ocean floor and tend to be fairly stable (low landslide potential). The headwaters of Music Creek and Taylor Creek are underlain by granitic bedrock which has been highly weathered (Figure 6 in Appendix A). This led to the development of highly weathered and dissected granitic lands, susceptible to shallow landsliding such as debris slides and debris flows.

The analysis of the Affected Environment includes Eddy Late Successional Reserve, Elk Thin, Fish Meadows, Glassups Timber Sale, Happy Camp Fire Protection Phase 2, Johnny O'Neil Late Successional Reserve Habitat Restoration and Fuels Reduction, Lake Mountain Foxtail Pine, Lower Scott Roads, North Fork Roads Storm-proofing, Oak Flat Thin, Singleton, Thom Seider Vegetation Management and Fuels Reduction, Two Bit Vegetation Management projects. As well as the work done under the Burned Area Emergency Response, grazing allotments, Timber Harvest Plans since 2005, and Private Land Salvage (Emergency Timber Harvest Plans). These

are on-going activities and the CWE model includes them in the "current" portion of the results. So to stay consistent for the analysis all of these projects are included in the analysis of the Affected Environment, which represents the effects of the past and on-going actions for this analysis.

The landslide risk is displayed by 7th field watershed in Table 3 of Appendix C. Of the sixty-seven 7th field watersheds analyzed, three currently have a very high landslide risk. These are Rancheria Creek, Walker Creek and Lower Grider Creek. The likelihood that a landslide event will occur in Lower Grider and Walker Creek is almost certain and highly likely in Rancheria Creek. These three watersheds have a catastrophic consequence if a landslide (specifically a debris flow) occurs due to the proximity to the creek of private property with residential structures. There are twenty watersheds with a high landslide risk mainly due to the susceptibility of municipal water supplies, fish habitat and ingress/egress to landslide events. Thirty of the watersheds analyzed have a moderate landslide risk and twelve have a low landslide risk.

There are forty 7th field watersheds that have more than 10% high or moderate vegetation burn severity (Table 6). These watersheds will have an elevated landslide risk of greater than 80 years. These include Rancharia Creek, Lower Grider Creek, and Walker Creek which have very high landlside risks and thirteen of the watersheds with high landslide risks. The other twenty seven watersheds are assumed to have acute elevated landslide risk that will last about 2-5 years.

Environmental Consequences

Alternative 1

Direct Effects and Indirect Effects

There are no direct effects to landslide risk under this alternative. The area will recover naturally including the re-establishment of vegetation and ground-cover, increasing root support and intercepting precipitation which reduces landslide risk and potential. However, prolonged hardwood and brush dominated occupancy will not provide the root support to maintain stable slopes (Jackson & Roering, 2009**)**. The landslide risk will remain the same as current conditions for about 10 to 12 years (Zeimer 1981) and slowly begin to reduce as conifer forest begins to be established. The project area may take up to 80 years to recover to a pre-fire landslide risk level. It could take longer in areas where seed sources have been eliminated due to large pockets of high and moderate severity vegetation burn such as Walker, Grider and O'Neil Creek.

Cumulative Effects

The projects added to the effects of the past actions (the affected environment) and the direct and indirect effects of the project are portions of the Jess project, Scott Bar Underburn, Lovers Canyon, McCollins and Sawyers Bar Fuels Reduction Project that are in the 7th field watersheds analyzed. The Jess project and Lovers Canyon project are the only two future projects that have any effect on the risk ratio or percent watershed with high or moderate disturbance. Jess project increases the risk ratio for 0.01 and 0.07 for the Eddy Gulch and Jessups Gulch respectively

(Table 3). The Jess project increases the percent of the watershed with high and moderate disturbance by 1.5% for both watersheds (Table 4). Lovers Canynon increases the risk ratios for South Fork Kelsey and Middle Creek by 0.03 and 0.02 respectively (Table 3) and the percent disturbed is increased by 3.3% for both watersheds(Table 4). The landslide risks are not increased by the addition of the effects of these projects. None of the projects effect the duration of elevated risk in the watersheds.

Alternative 2

Direct and Indirect Effects

There are about 3920 acres of salvage units (about 2,000 acres of salavage logging) on steep, weathered granitic lands (Riparian Reserve) proposed in this alternative. No Salvage will occur on inner gorges, active landslides or toe zones of dormant landslides (see Chapter 2 of the EIS for project design features). Also proposed are about 960 acres of site preparation and planting, 4395 acres of roadside hazard tree removal and 3940 acres of fuels treatments on unstable lands considered to be Riparian Reserves.

Alternative 2 does not change the landslide risk for any watershed (Table 4). There is a change in the risk ratio or the percent watershed high or moderate disturbance for twenty-eight watersheds (Table 7). The average change in risk ratio is 0.01 and the maximum change was 0.11. The average change in percent watershed with high and moderate disturbance is 0.24% and the maximum change is 1.1%.

The effects of re-opening temporary roads on existing roadbeds and decommissioned roads or building new temporary roads is incorporated into the landslide risk assessment. The main effect on landslide risk from road crossings is the increase in debris flow volume when the debris flow removes the crossing and the material gets incorporated into the debris flow. Debris flow volume is directly correlated with the probability of damage of structure, infrastructure (roads, power corridors, water lines, etc.) and natural resources. The more crossings in a watershed the more likely that if a debris flow should occur the volume will be increased. Crossings built on new temporary roads or re-constructed on decommissioned or existing temporary roads will be removed before the rainy season (see Chapter 2 of DEIS). So the excess material will be removed before debris flow events are likely making the increase in risk small. In areas where roadbeds are narrowed due to road-fill related landslides could add weight to the head of the landslide which could cause it to re-activate if a landslide producing storm should occur before vegetation is re-established.

Caroline Creek 7th field has a high landslide risk. There is a moderate consequence of a landslide event due to the vulnerability of fisheries resources in the watershed. The decommissioned road (46N62) in Gard Creek experienced a debris flow in the 1997 flood event that affected the Gard Creek crossing. There is also an active landslide that is narrowing the roadbed. Re-opening of the road will require the reinstallation of the stream crossing and widening the road on an active landslide. This work was incorporated into the 7th field watershed risk call for Caroline Creek. However, at the site scale the probability of re-activating the landslide by temporarily widening the road is moderate. Widening the road could add weight to the head of the landslide which could cause it to re-activate if a landslide producing storm should occur before vegetation is re-

established. The effect of a temporary crossing on Gard Creek will be small because the fill will be removed before the rainy season when debris flows are most likely (see Chapter 2 of DEIS).

There is a reduction in the duration of elevated risk for nine watersheds compared to alternative 1. The 7th field watersheds with a high landslide risk that will have a reduced duration of elevated risk are Upper Grider Creek, Cliff Valley, Lower Grider Creek, O'Neil Creek, Walker Creek, and Caroline Creek. These watersheds have a high percentage of steep, weathered granitic lands so the project will benefit this Riparian Reserve landform in the long-term by decreasing the duration of elevated risk of landslide events. The reduction in duration of elevated risk will benefit natural resources and infrastruction in the long-term. Middle Creek, Horse Creek, and Upper Elk Creek have a moderate landslide risk and will have a duration of elevated risk of 30 years in this alternative. Lower Grider and Walker Creek have very high landslide risk due to the potential to impact private land – so the reduction of elevated risk from more than 80 years to 30 years is of great benefit for protecting human safety and private property in these two watersheds. Rancheria Creek, which also has a very high landslide risk, will continue to have a greater than 80 year duration of elevated risk because there is less than 25% of the high and moderate vegetation burn severity areas being planted. All other watersheds will have a greater than 80 year duration of elevated risk. (See Table 6)

Cumulative Effects

The projects added to the effects of the past actions (the affected environment) and the direct and indirect effects of the project are portions of the Jess project, Salmon Reforestation, Scott Bar Underburn, Lovers Canyon, McCollins and Sawyers Bar Fuels Reduction Project that are in the 7th field watersheds analyzed. The Jess project and Lovers Canyon project are the only two future projects that have any effect on the risk ratio or percent watershed with high or moderate disturbance. Jess project increases the risk ratio for 0.01 and 0.07 for the Eddy Gulch and Jessups Gulch respectively (Table 3). The Jess project increases the percent of the watershed with high and moderate disturbance by 1.5% for both watersheds (Table 4). Lovers Canynon increases the risk ratios for South Fork Kelsey and Middle Creek by 0.03 and 0.02 respectively (Table 3) and the percent disturbed is increased by 3.3% for both watersheds(Table 4). The landslide risks are not increased for any 7th field watershed by the addition of the effects of these projects. None of the projects effect the duration of elevated risk in the watersheds.

Alternative 3

Direct and Indirect Effects

There are about 3750 acres of salvage units (about 1,900 acres of salvage logging) on steep, weathered granitic lands (Riparian Reserve) proposed in this alternative. No Salvage will occur on inner gorges, active landslides or toe zones of dormant landslides (see Chapter 2 of the EIS for project design features). Also proposed are about 960 acres of site preparation and planting, 4395 acres of roadside hazard tree removal and 3940 acres of fuels treatments on unstable lands considered to be Riparian Reserves. The effects as a result of temporary roads and the re-opening the 46N62 in Gard Creek is the same as for Alternative 2.

The indirect effects to the landslide risk are the same as for alternative 2 (Table 5). The duration of elevated risk will not be reduced in Horse Creek, because the percent of the 7th field planted

drops below 25% (Table 6). All other duration of elevated risks will remain the same as alternative 2.

Cumulative Effects

The cumulative effects are the same as for Alterntive 2.

Alternative 4

Direct and Indirect Effects

There are about 3740 acres of salvage units (about 1,900 acres of salvage logging) on steep, weathered granitic lands (Riparian Reserve) proposed in this alternative. No Salvage will occur on inner gorges, active landslides or toe zones of dormant landslides (see Chapter 2 of the EIS for project design features). Also proposed are about 960 acres of site preparation and planting, 4290 acres of roadside hazard tree removal and 3940 acres of fuels treatments on unstable lands considered to be Riparian Reserves. The Gard Creek road is not re-openeded in this alternative. However, the general effects of re-opening temporary roads on existing roadbeds and decommissioned roads or building new temporary roads are the same as for alternative 2.

The indirect effects to landslide risk are the same as for alternative 2. There are only five 7th field watersheds that have a reduction in the duration of elevated risk (Table 6). Lower Grider will have an elevated risk for more than 80 years under this alternative compared to 30 years in alternative 2. Upper Grider Creek, Horse Creek, and Upper Elk will have an elevated risk for more than 80 years compared to 30 years under alternative 2. All other duration of elevated risk are the same as alternative 2.

Cumulative Effects

The cumulative effects are the same as for Alterntive 2.

Alternative 5

Direct and Indirect Effects

There are about 465 acres of salvage untis (250 acres of salvage logging) on steep, weathered granitic lands (Riparian Reserve) proposed in this alternative. No Salvage will occur on inner gorges, active landslides or toe zones of dormant landslides (see Chapter 2 of the EIS for project design features). Also proposed are about 960 acres of site preparation and planting, 4395 acres of roadside hazard tree removal and 3970 acres of fuels treatments on unstable lands considered to be Riparian Reserves. The effects as a result of temporary roads and the re-opening the 46N62 in Gard Creek is the same as for Alternative 2. The indirect effects for landslide risk are the same as for alternative 2. The duration of elevated risk is the same as for alternative 4.

Cumulative Effects

The cumulative effects are the same as for Alterntive 2.

Comparison of Alternatives

Table 2: Comparison of Alternatives for 7th field watersheds with effects to duration of elevated risk.

7th field Watershed	Landslide Risk	Duration of Elevated Risk Alternative 1	Duration of Elevated Risk Alternative 2	Duration of Elevated Risk Alternative 3	Duration of Elevated Risk Alternative 4	Duration of Elevated Risk Alternative 5
Upper Grider Creek	High	Greater than 80 years	30 years	30 years	Greater than 80 years	Greater than 80 years
Cliff Valley	High	Greater than 80 years	30 years	30 years	30 years	30 years
Lower Grider Creek	Very High	Greater than 80 years	30 years	30 years	Greater than 80 years	Greater than 80 years
O'Neil Creek	High	Greater than 80 years	30 years	30 years	30 years	30 years
Walker Creek	Very High	Greater than 80 years	30 years	30 years	30 years	30 years
Caroline Creek	High	Greater than 80 years	30 years	30 years	30 years	30 years
Middle Creek	Moderate	Greater than 80 years	30 years	30 years	30 years	30 years
Horse Creek	Moderate	Greater than 80 years	30 years	Greater than 80 years	Greater than 80 years	Greater than 80 years
Upper Elk Creek	Moderate	Greater than 80 years	30 years	30 years	Greater than 80 years	Greater than 80 years

There is no change in landslide risk compared to current conditions for any alternative. The duration of elevated risk is changed for nine 7th field watersheds in alternative 2 and for eight in Alternative 3. Two of the three watersheds with very high landslide risk have a decrease in the duration of elevated risk for alternatives 2 and 3. Alternatives 4 and 5 reduce the number of watersheds with shortened duration of elevated risk to five 7th field watersheds and only one watershed with a very high landslide risk, Walker Creek, has a reduced duration of elevated risk. (see Table 2)

Compliance with law, regulation, policy, and the Forest Plan

The project is compliant with the Klamath National Forest Plan (1995, as amended) Standards and Guidelines. A geologic investigation was completed and natural regeneration of vegetation on unstable lands will improve slope stability in portions of the project area but recovery could take between 30-80 years.

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Appendix A – Maps

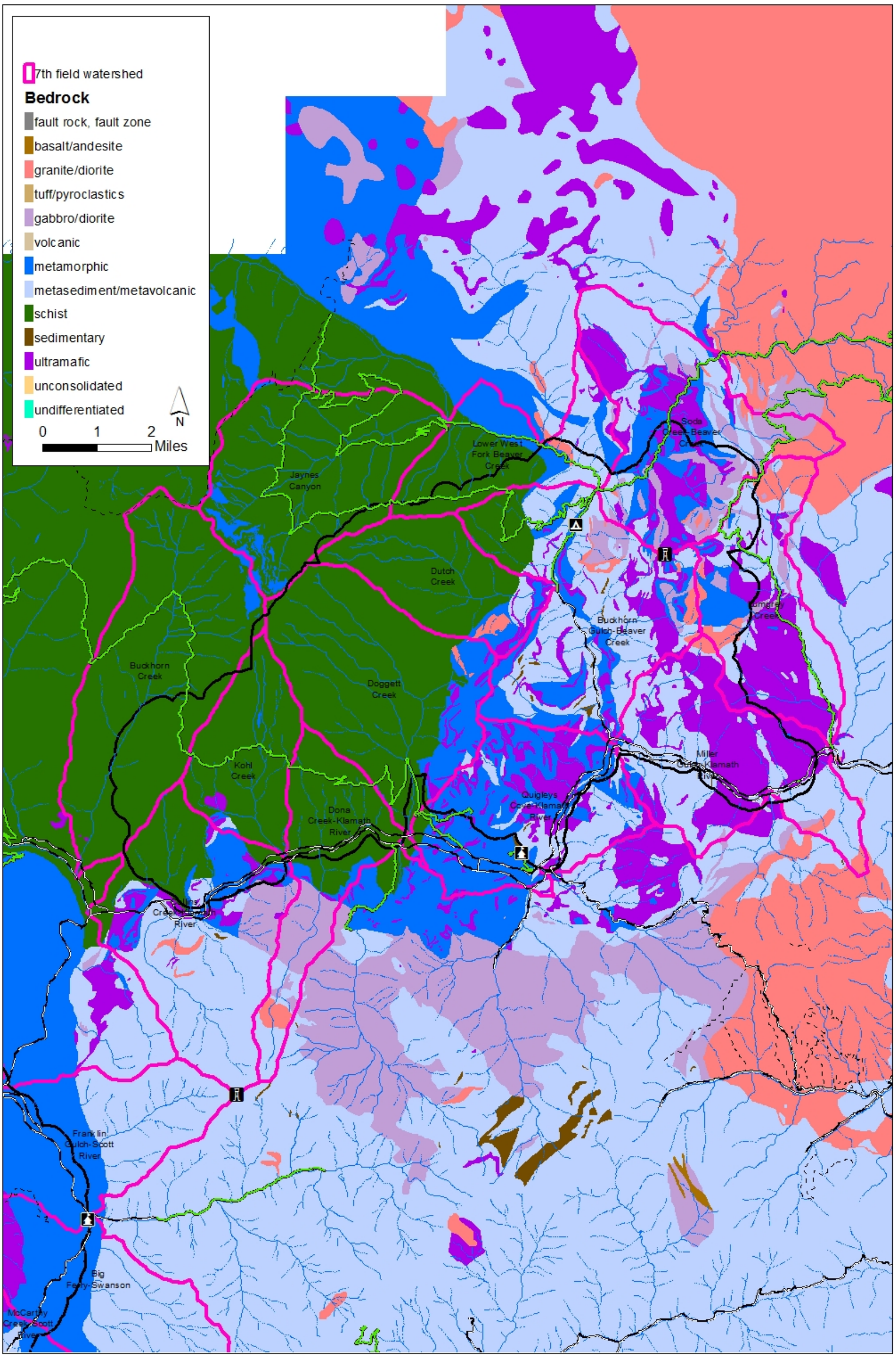

Figure 1: Beaver fire area bedrock.

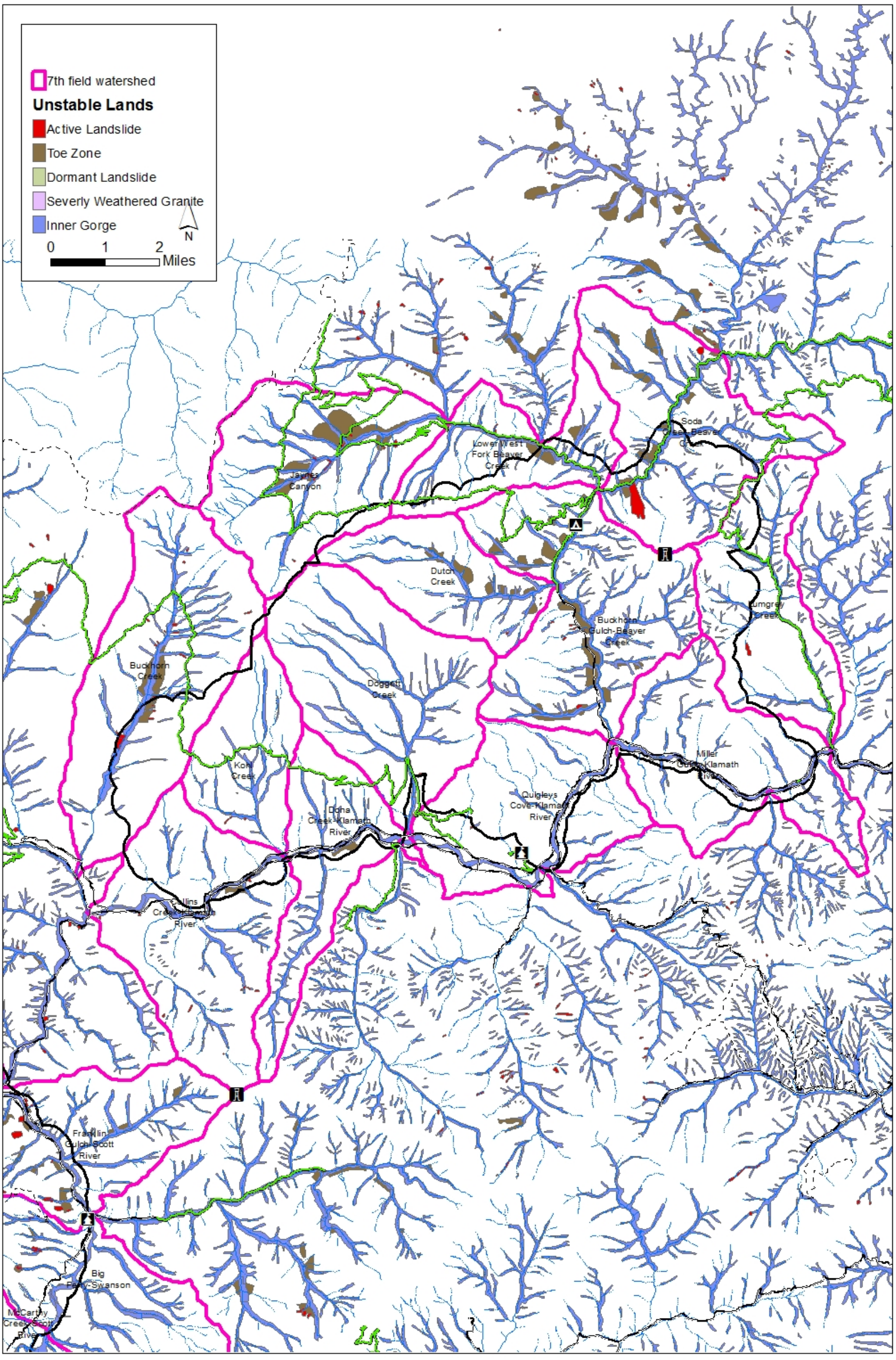

Figure 2: Beaver fire area unstable lands.

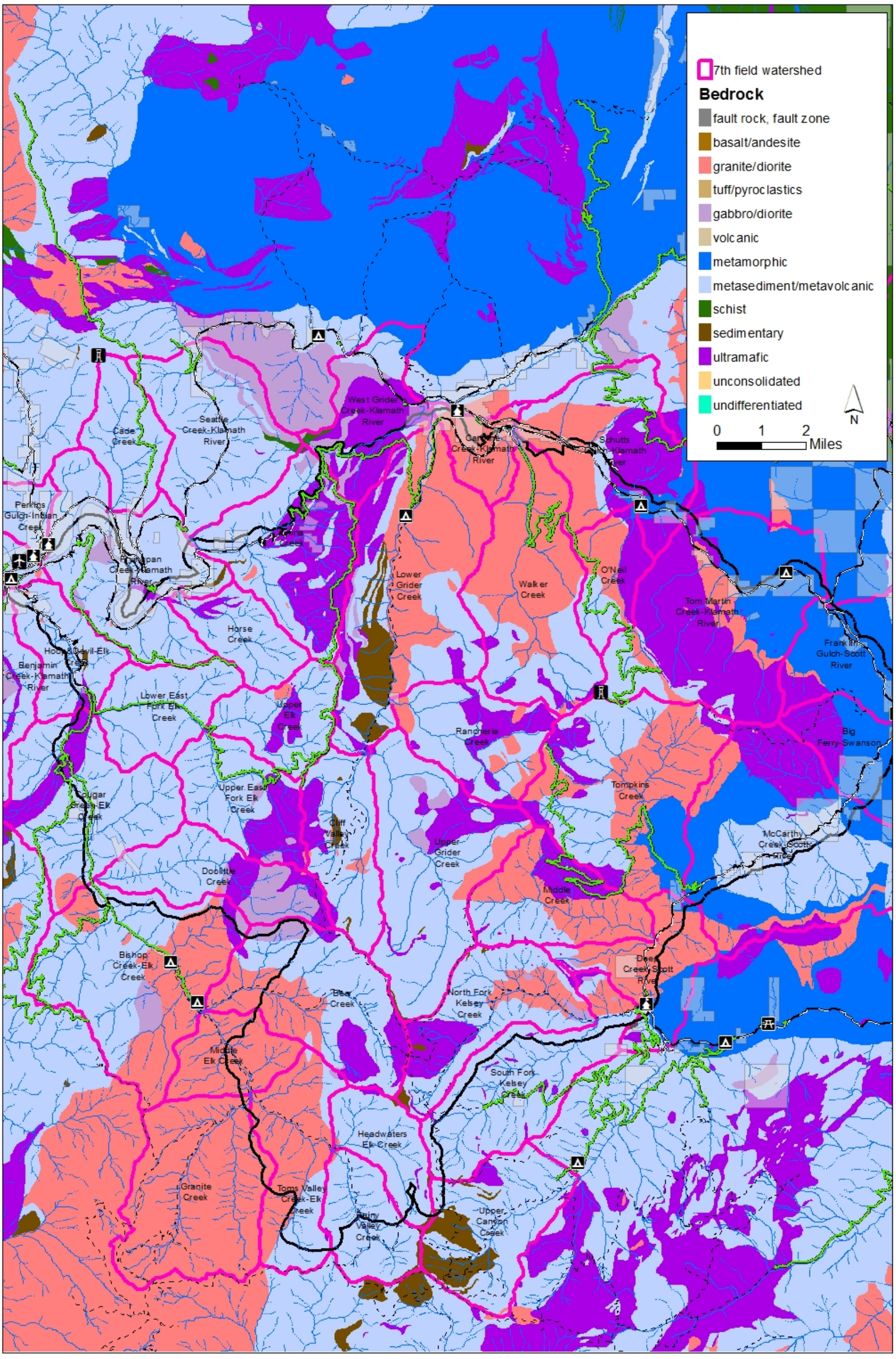

Figure 3: Happy Camp fire bedrock.

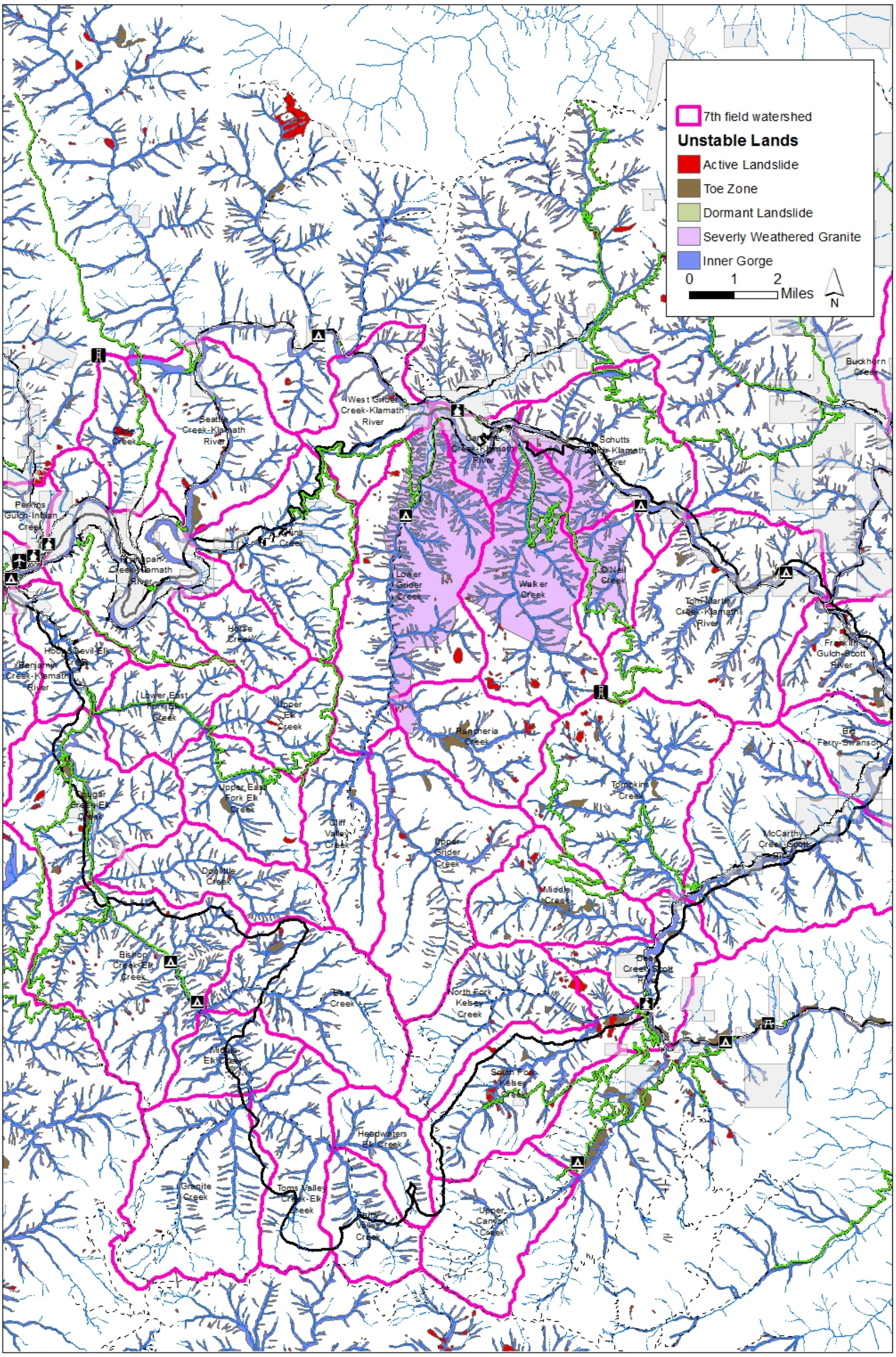

Figure 4: Happy Camp fire area unstable lands.

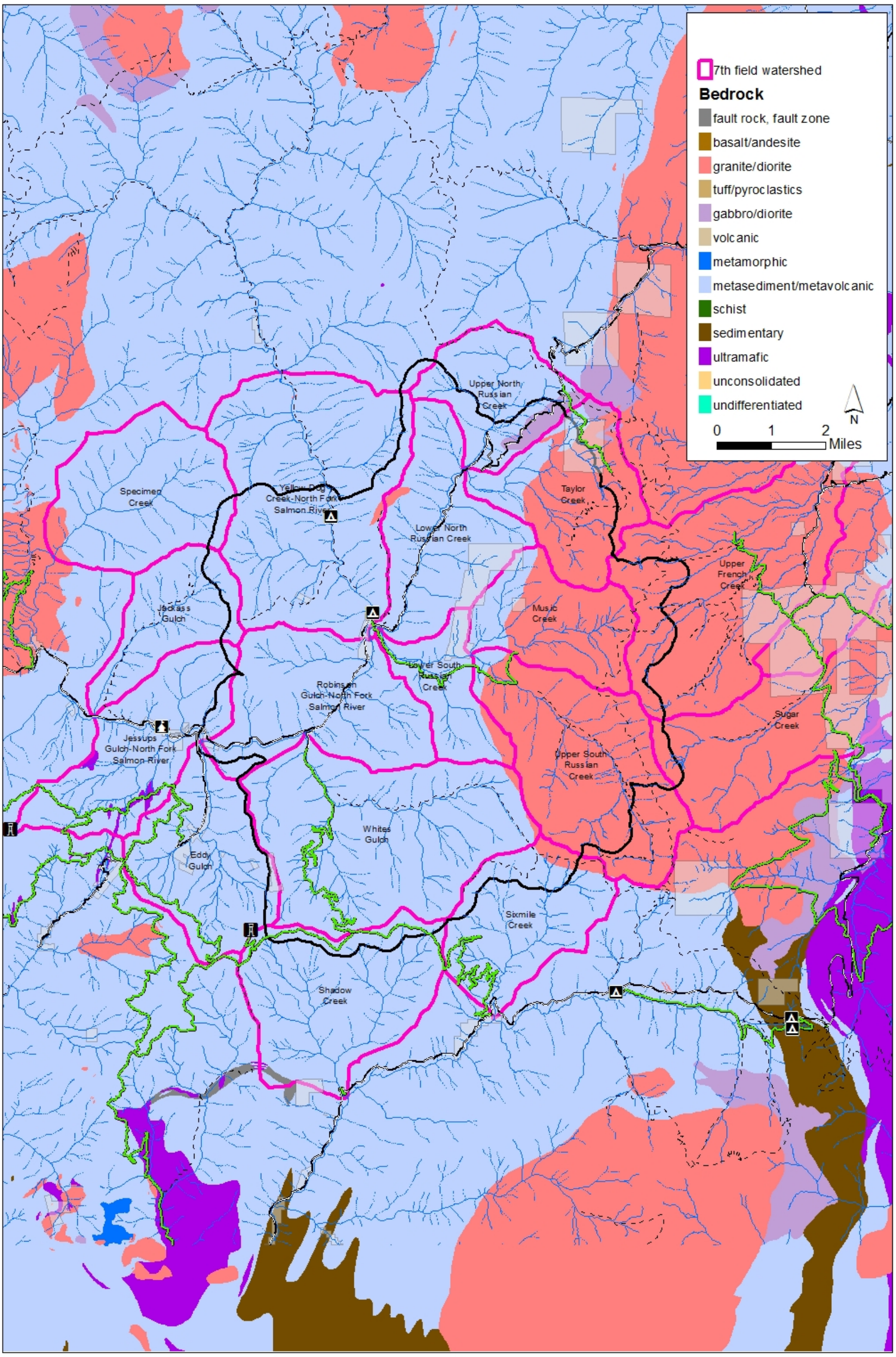

Figure 5: Whites fire area bedrock.

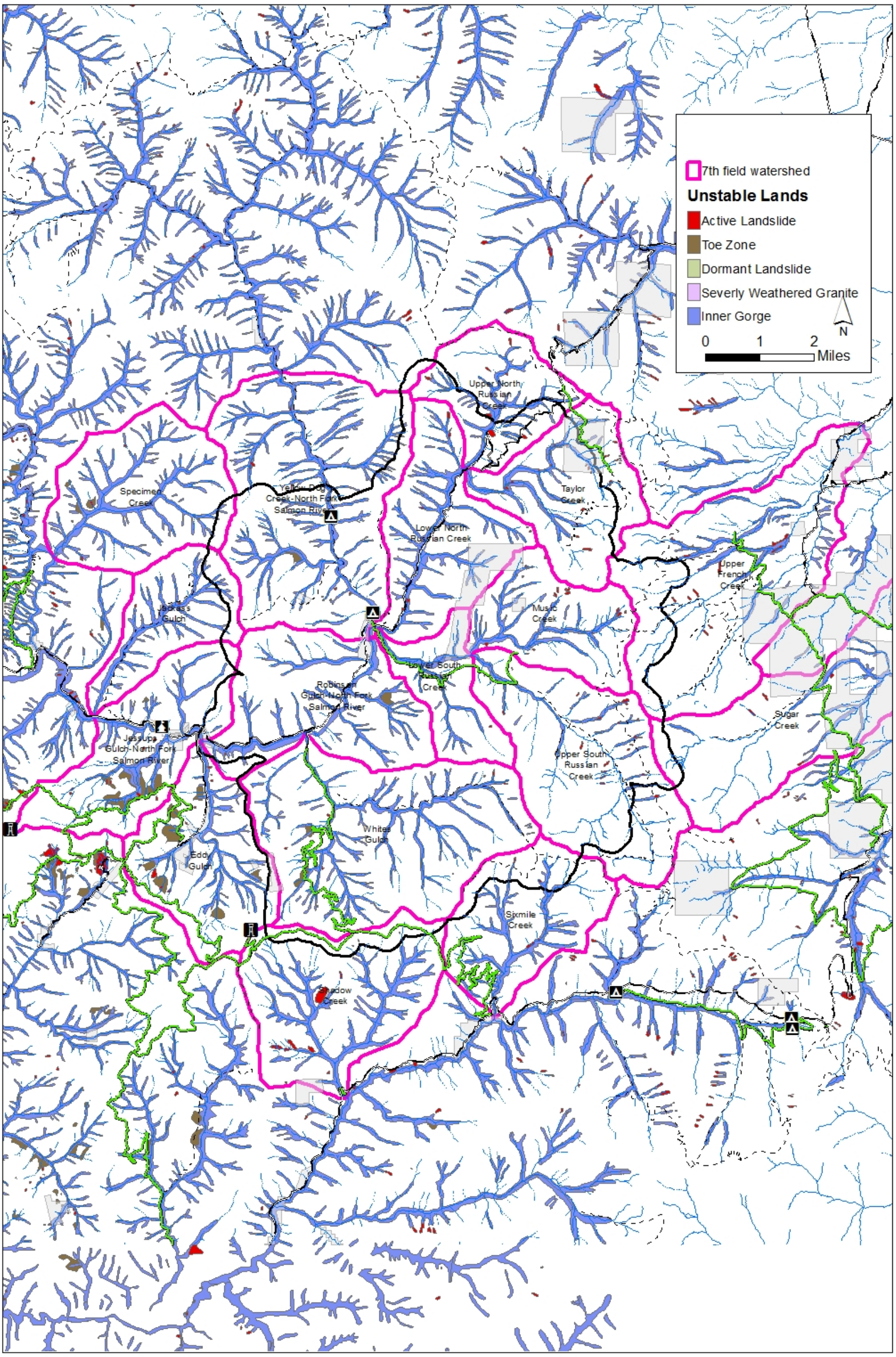

Figure 6: Whites fire area unstable lands.

Appendix B – Landslide Risk Analysis

Table 3: Landslide Risk Assessment for the Affected Environment and No Action.

.Watershed Code	Watershed Name	Consequence of Landslide Event	Percent Watershed Unstable	Current Risk Ratio	Percent Distrubance last decade	Current Landslide Likelihood	Current Landslide Risk
18010206080302	Lumgrey Creek	Moderate	9.5%	1.04	2.1%	Highly Likely	High
18010206080304	Miller Gulch-Klamath River	Minor	10.3%	0.75	8.6%	Likely	Low
18010206090203	Soda Creek-Beaver Creek	Moderate	17.0%	1.46	12.7%	Highly Likely	High
18010206090301	Jaynes Canyon	Moderate	14.3%	0.85	14.8%	Likely	Moderate
18010206090304	Lower West Fork Beaver Creek	Moderate	13.5%	1.05	12.0%	Highly Likely	High
18010206090401	Dutch Creek	Minor	13.0%	0.93	45.2%	Highly Likely	Moderate
18010206090402	Buckhorn Gulch-Beaver Creek	Moderate	18.1%	1.16	55.1%	Highly Likely	High
18010206100202	Quigleys Cove-Klamath River	Moderate	5.9%	0.72	21.7%	Likely	Moderate
18010206100301	Doggett Creek	Moderate	9.7%	1.11	49.3%	Highly Likely	High
18010206100303	Dona Creek-Klamath River	Minor	12.8%	1.16	25.6%	Highly Likely	Moderate
18010206100406	Buckhorn Creek	Moderate	11.2%	0.68	10.5%	Likely	Moderate
18010206100501	Kohl Creek	Moderate	8.1%	1.18	66.9%	Highly Likely	High
18010206100502	Collins Creek-Klamath River	Moderate	8.8%	0.78	13.7%	Likely	Moderate
18010206110101	Upper Grider Creek	Catastrophic	11.5%	0.31	24.0%	Likely	High
18010206110102	Cliff Valley Creek	Catastrophic	12.3%	0.33	12.8%	Likely	High
18010206110103	Rancheria Creek	Catastrophic	21.6%	0.68	46.4%	Highly Likely	Very High
18010206110104	Lower Grider Creek	Catastrophic	58.5%	1.09	36.5%	Almost Certain	Very High
18010206110301	Tom Martin Creek-Klamath River	Minor	16.3%	0.44	26.2%	Highly Likely	Moderate
18010206110303	O'Neil Creek	Moderate	56.1%	1.5	28.6%	Almost Certain	High
18010206110304	Schutts Gulch-Klamath River	Nuisance	31.3%	1.15	6.8%	Highly Likely	Low
18010206110305	Walker Creek	Catastrophic	69.8%	1.89	29.6%	Almost Certain	Very High
18010206110306	Caroline Creek-Klamath River	Moderate	68.4%	1.64	11.4%	Almost Certain	High
18010206110307	West Grider Creek-Klamath River	Minor	16.0%	0.59	2.3%	Likely	Low
18010208020301	Upper French Creek	Moderate	5.8%	0.78	4.8%	Likely	Moderate
18010208020402	Sugar Creek	Minor	5.4%	0.45	0.1%	Unlikely	Very Low
18010208060101	Upper Canyon Creek	Minor	5.3%	0.07	2.8%	Unlikely	Very Low
18010208060301	North Fork Kelsey Creek	Moderate	12.0%	0.46	17.7%	Likely	Moderate
18010208060302	South Fork Kelsey Creek	Moderate	16.1%	0.35	2.6%	Likely	Moderate
18010208060401	Middle Creek	Minor	15.0%	1.09	19.6%	Highly Likely	Moderate
18010208060402	Deep Creek-Scott River	Minor	16.7%	1.39	10.1%	Highly Likely	Moderate
18010208060403	Tompkins Creek	Moderate	15.5%	0.85	18.6%	Likely	Moderate
18010208060601	McCarthy Creek-Scott River	Moderate	13.3%	0.43	18.1%	Likely	Moderate

18010208060602	Big Ferry-Swanson	Moderate	10.9%	0.61	31.5%	Highly Likely	High
18010208060603	Franklin Gulch-Scott River	Minor	17.4%	0.39	11.3%	Likely	Low
18010209020302	China Creek	Moderate	12.6%	0.75	5.2%	Likely	Moderate
18010209020303	Horse Creek	Moderate	14.9%	0.76	12.5%	Likely	Moderate
18010209020305	Fryingpan Creek-Klamath River	Moderate	14.4%	0.75	5.1%	Likely	Moderate
18010209030101	Headwaters Elk Creek	Moderate	11.4%	0.15	21.7%	Likely	Moderate
18010209030102	Rainy Valley Creek	Moderate	12.2%	0.02	5.2%	Likely	Moderate
18010209030103	Toms Valley Creek-Elk Creek	Moderate	11.2%	0.6	14.9%	Likely	Moderate
18010209030104	Granite Creek	Moderate	9.3%	1.52	32.8%	Almost Certain	High
18010209030105	Middle Elk Creek	Moderate	18.9%	2.85	56.0%	Almost Certain	High
18010209030201	Upper East Fork Elk Creek	Moderate	13.0%	0.54	22.9%	Likely	Moderate
18010209030202	Upper Elk Creek	Moderate	13.8%	0.43	17.7%	Likely	Moderate
18010209030203	Lower East Fork Elk Creek	Moderate	15.4%	0.48	21.1%	Likely	Moderate
18010209030301	Bear Creek	Moderate	12.9%	1.01	26.4%	Highly Likely	High
18010209030302	Bishop Creek-Elk Creek	Moderate	17.6%	1.76	18.0%	Highly Likely	High
18010209030303	Doolittle Creek	Moderate	15.3%	0.46	25.7%	Highly Likely	High
18010209030304	Cougar Creek-Elk Creek	Moderate	16.4%	0.64	6.3%	Likely	Moderate
18010209030305	Hoop&Devil-Elk Creek	Moderate	15.2%	0.6	2.1%	Likely	Moderate
18010209060103	Benjamin Creek-Klamath River	Minor	15.6%	0.63	5.1%	Likely	Low
18010210010304	Sixmile Creek	Minor	13.6%	0.38	2.2%	Likely	Low
18010210010306	Shadow Creek	Minor	17.3%	0.45	3.7%	Likely	Low
18010210020301	Upper South Russian Creek	Minor	4.4%	0.78	19.6%	Likely	Low
18010210020302	Music Creek	Minor	13.5%	1.21	43.5%	Highly Likely	Moderate
18010210020303	Lower South Russian Creek	Moderate	12.6%	0.66	20.7%	Likely	Moderate
18010210020401	Upper North Russian Creek	Minor	14.5%	0.98	4.3%	Highly Likely	Moderate
18010210020402	Taylor Creek	Minor	10.7%	0.53	13.3%	Likely	Low
18010210020403	Lower North Russian Creek	Moderate	18.8%	0.83	34.1%	Highly Likely	High
18010210020502	Big Creek	Minor	14.9%	0	0.0%	Likely	Low
18010210020503	Yellow Dog Creek-North Fork Salmon River	Major	16.1%	0.28	13.7%	Likely	High
18010210020603	Specimen Creek	Minor	18.0%	0.65	0.2%	Likely	Low
18010210020701	Whites Gulch	Moderate	13.4%	0.64	31.7%	Highly Likely	High
18010210020702	Robinson Gulch-North Fork Salmon River	Minor	17.0%	0.8	41.3%	Highly Likely	Moderate
18010210020703	Eddy Gulch	Moderate	16.4%	0.76	0.0%	Likely	Moderate
18010210020704	Jessups Gulch-North Fork Salmon River	Major	15.6%	0.59	0.1%	Likely	High
18010210020705	Jackass Gulch	Minor	18.7%	0.19	16.0%	Likely	Low

Table 4: Landslide Risk Assessment for Alternative 2 and Actions Considered for Cumulative Effects.

Watershed Code	Watershed Name	Alt 2 Risk Ratio	Total Percent Distrubance (current % plus Alt 2 %)	Alt. 2 Landslide Likelihood	Alt. 2 Landslide Risk	Cumulative Risk Ratio	Total percent distrubance (current % plus Alt 2 % plus Future %)	Alt 2 Cumulative Landslide Likelihood	Alt 2 Cumulative Landslide Risk
18010206080302	Lumgrey Creek	1.04	2.1%	Highly Likely	High	1.04	2.1%	Highly Likely	High
18010206080304	Miller Gulch-Klamath River	0.75	8.6%	Likely	Low	0.75	8.6%	Likely	Low
18010206090203	Soda Creek-Beaver Creek	1.46	12.7%	Highly Likely	High	1.46	12.7%	Highly Likely	High
18010206090301	Jaynes Canyon	0.85	14.8%	Likely	Moderate	0.85	14.8%	Likely	Moderate
18010206090304	Lower West Fork Beaver Creek	1.05	12.0%	Highly Likely	High	1.05	12.0%	Highly Likely	High
18010206090401	Dutch Creek	0.96	45.4%	Highly Likely	Moderate	0.96	45.4%	Highly Likely	Moderate
18010206090402	Buckhorn Gulch-Beaver Creek	1.17	55.2%	Highly Likely	High	1.17	55.2%	Highly Likely	High
18010206100202	Quigleys Cove-Klamath River	0.76	21.8%	Likely	Moderate	0.76	21.8%	Likely	Moderate
18010206100301	Doggett Creek	1.15	49.4%	Highly Likely	High	1.15	49.4%	Highly Likely	High
18010206100303	Dona Creek-Klamath River	1.2	25.6%	Highly Likely	Moderate	1.2	25.6%	Highly Likely	Moderate
18010206100406	Buckhorn Creek	0.68	10.5%	Likely	Moderate	0.68	10.5%	Likely	Moderate
18010206100501	Kohl Creek	1.19	67.0%	Highly Likely	High	1.19	67.0%	Highly Likely	High
18010206100502	Collins Creek-Klamath River	0.78	13.7%	Likely	Moderate	0.78	13.7%	Likely	Moderate
18010206110101	Upper Grider Creek	0.35	24.2%	Likely	High	0.35	24.2%	Likely	High
18010206110102	Cliff Valley Creek	0.34	13.1%	Likely	High	0.34	13.1%	Likely	High
18010206110103	Rancheria Creek	0.68	46.4%	Highly Likely	Very High	0.68	46.4%	Highly Likely	Very High
18010206110104	Lower Grider Creek	1.11	36.8%	Almost Certain	Very High	1.11	36.8%	Almost Certain	Very High
18010206110301	Tom Martin Creek-Klamath River	0.46	26.3%	Highly Likely	Moderate	0.46	26.3%	Highly Likely	Moderate
18010206110303	O'Neil Creek	1.51	29.1%	Almost Certain	High	1.51	29.1%	Almost Certain	High
18010206110304	Schutts Gulch-Klamath River	1.15	6.8%	Highly Likely	Low	1.15	6.8%	Highly Likely	Low
18010206110305	Walker Creek	1.92	29.8%	Almost Certain	Very High	1.92	29.8%	Almost Certain	Very High
18010206110306	Caroline Creek-Klamath River	1.72	12.5%	Almost Certain	High	1.72	12.5%	Almost Certain	High
18010206110307	West Grider Creek-Klamath River	0.59	2.3%	Likely	Low	0.59	2.3%	Likely	Low
18010208020301	Upper French Creek	0.78	4.8%	Likely	Moderate	0.78	4.8%	Likely	Moderate
18010208020402	Sugar Creek	0.45	0.1%	Unlikely	Very Low	0.45	0.1%	Unlikely	Very Low
18010208060101	Upper Canyon Creek	0.07	2.8%	Unlikely	Very Low	0.07	2.8%	Unlikely	Very Low
18010208060301	North Fork Kelsey Creek	0.46	17.7%	Likely	Moderate	0.46	17.7%	Likely	Moderate
18010208060302	South Fork Kelsey Creek	0.35	2.6%	Likely	Moderate	0.38	5.9%	Likely	Moderate
18010208060401	Middle Creek	1.2	19.9%	Highly Likely	Moderate	1.2	19.9%	Highly Likely	Moderate
18010208060402	Deep Creek-Scott River	1.39	10.1%	Highly Likely	Moderate	1.41	13.9%	Highly Likely	Moderate
18010208060403	Tompkins Creek	0.86	18.7%	Likely	Moderate	0.86	18.7%	Likely	Moderate
18010208060601	McCarthy Creek-Scott River	0.43	18.2%	Likely	Moderate	0.43	18.2%	Likely	Moderate
18010208060602	Big Ferry-Swanson	0.61	31.6%	Highly Likely	High	0.61	31.6%	Highly Likely	High

18010208060603	Franklin Gulch-Scott River	0.39	11.3%	Likely	Low	0.39	11.3%	Likely	Low
18010209020302	China Creek	0.77	5.6%	Likely	Moderate	0.77	5.6%	Likely	Moderate
18010209020303	Horse Creek	0.85	13.2%	Likely	Moderate	0.85	13.2%	Likely	Moderate
18010209020305	Fryingpan Creek-Klamath River	0.75	5.3%	Likely	Moderate	0.75	5.3%	Likely	Moderate
18010209030101	Headwaters Elk Creek	0.15	21.7%	Likely	Moderate	0.15	21.7%	Likely	Moderate
18010209030102	Rainy Valley Creek	0.02	5.2%	Likely	Moderate	0.02	5.2%	Likely	Moderate
18010209030103	Toms Valley Creek-Elk Creek	0.6	14.9%	Likely	Moderate	0.6	14.9%	Likely	Moderate
18010209030104	Granite Creek	1.52	32.8%	Almost Certain	High	1.52	32.8%	Almost Certain	High
18010209030105	Middle Elk Creek	2.85	56.0%	Almost Certain	High	2.85	56.0%	Almost Certain	High
18010209030201	Upper East Fork Elk Creek	0.5	23.0%	Likely	Moderate	0.5	23.0%	Likely	Moderate
18010209030202	Upper Elk Creek	0.41	18.5%	Likely	Moderate	0.41	18.5%	Likely	Moderate
18010209030203	Lower East Fork Elk Creek	0.43	21.3%	Likely	Moderate	0.43	21.3%	Likely	Moderate
18010209030301	Bear Creek	1.01	26.4%	Highly Likely	High	1.01	26.4%	Highly Likely	High
18010209030302	Bishop Creek-Elk Creek	1.76	18.0%	Highly Likely	High	1.76	18.0%	Highly Likely	High
18010209030303	Doolittle Creek	0.44	25.7%	Highly Likely	High	0.44	25.7%	Highly Likely	High
18010209030304	Cougar Creek-Elk Creek	0.6	6.3%	Likely	Moderate	0.6	6.3%	Likely	Moderate
18010209030305	Hoop&Devil-Elk Creek	0.57	2.1%	Likely	Moderate	0.57	2.1%	Likely	Moderate
18010209060103	Benjamin Creek-Klamath River	0.63	5.1%	Likely	Low	0.63	5.1%	Likely	Low
18010210010304	Sixmile Creek	0.38	2.2%	Likely	Low	0.38	2.2%	Likely	Low
18010210010306	Shadow Creek	0.45	3.7%	Likely	Low	0.45	3.7%	Likely	Low
18010210020301	Upper South Russian Creek	0.78	19.7%	Likely	Low	0.78	19.7%	Likely	Low
18010210020302	Music Creek	1.21	43.5%	Highly Likely	Moderate	1.21	43.5%	Highly Likely	Moderate
18010210020303	Lower South Russian Creek	0.66	20.7%	Likely	Moderate	0.66	20.7%	Likely	Moderate
18010210020401	Upper North Russian Creek	0.98	4.3%	Highly Likely	Moderate	0.98	4.3%	Highly Likely	Moderate
18010210020402	Taylor Creek	0.53	13.3%	Likely	Low	0.53	13.3%	Likely	Low
18010210020403	Lower North Russian Creek	0.83	34.1%	Highly Likely	High	0.83	34.1%	Highly Likely	High
18010210020502	Big Creek	0	0.0%	Likely	Low	0	0.0%	Likely	Low
18010210020503	Yellow Dog Creek-North Fork Salmon River	0.28	13.7%	Likely	High	0.28	13.7%	Likely	High
18010210020603	Specimen Creek	0.65	0.2%	Likely	Low	0.65	0.2%	Likely	Low
18010210020701	Whites Gulch	0.64	31.9%	Highly Likely	High	0.64	31.9%	Highly Likely	High
18010210020702	Robinson Gulch-North Fork Salmon River	0.8	41.3%	Highly Likely	Moderate	0.8	41.3%	Highly Likely	Moderate
18010210020703	Eddy Gulch	0.76	0.0%	Likely	Moderate	0.77	1.5%	Likely	Moderate
18010210020704	Jessups Gulch-North Fork Salmon River	0.59	0.1%	Likely	High	0.66	15.1%	Likely	High
18010210020705	Jackass Gulch	0.19	16.0%	Likely	Low	0.19	16.0%	Likely	Low

Table 5: Results of percent high and moderate disturbance analysis for alterantive 3, 4 and 5. Cumulative percent disturbance includes the high and moderate disturbance expected from future actions analyzed in the cumulative effects analysis.

Alt3 Disturbance (acre)	Percent Distrubance for Alt 3	Cumulative Percent Disturbance Alt 3	Alt4 Disturbance (acre)	Percent Distrubance for Alt 4	Cumulative Percent Disturbance Alt 4	Alt5 Disturbance (acre)	Percent Distrubance for Alt 5	Cumulative Percent Disturbance Alt 5
0.00	2.1%	2.1%	0.00	2.1%	2.1%	0.00	2.1%	2.1%
0.00	8.6%	8.6%	0.00	8.6%	8.6%	0.00	8.6%	8.6%
0.00	12.7%	12.7%	0.00	12.7%	12.7%	0.00	12.7%	12.7%
0.00	14.8%	14.8%	0.00	14.8%	14.8%	0.00	14.8%	14.8%
0.00	12.0%	12.0%	0.00	12.0%	12.0%	0.00	12.0%	12.0%
7.52	45.4%	45.4%	3.02	45.3%	45.3%	4.49	45.3%	45.3%
7.13	55.2%	55.2%	3.02	55.1%	55.1%	2.60	55.1%	55.1%
3.98	21.8%	21.8%	3.98	21.8%	21.8%	3.98	21.8%	21.8%
9.62	49.4%	49.4%	4.74	49.4%	49.4%	8.11	49.4%	49.4%
1.20	25.6%	25.6%	0.99	25.6%	25.6%	1.20	25.6%	25.6%
5.92	10.5%	10.5%	5.92	10.5%	10.5%	0.00	10.5%	10.5%
4.78	67.0%	67.0%	4.29	67.0%	67.0%	1.02	66.9%	66.9%
2.42	13.7%	13.7%	2.42	13.7%	13.7%	0.00	13.7%	13.7%
19.68	24.2%	24.2%	3.87	24.0%	24.0%	18.16	24.2%	24.2%
12.78	13.1%	13.1%	3.02	12.8%	12.8%	5.22	12.9%	12.9%
0.00	46.4%	46.4%	0.00	46.4%	46.4%	0.00	46.4%	46.4%
33.47	36.8%	36.8%	21.02	36.7%	36.7%	18.76	36.7%	36.7%
12.95	26.3%	26.3%	12.95	26.3%	26.3%	9.29	26.3%	26.3%
12.25	29.1%	29.1%	6.12	28.9%	28.9%	9.63	29.0%	29.0%
2.35	6.8%	6.8%	1.88	6.8%	6.8%	2.35	6.8%	6.8%
18.50	29.8%	29.8%	9.99	29.7%	29.7%	10.93	29.7%	29.7%
20.14	12.5%	12.5%	7.04	11.8%	11.8%	20.14	12.5%	12.5%
0.00	2.3%	2.3%	0.00	2.3%	2.3%	0.00	2.3%	2.3%
0.00	4.8%	4.8%	0.00	4.8%	4.8%	0.00	4.8%	4.8%
0.00	0.1%	0.1%	0.00	0.1%	0.1%	0.00	0.1%	0.1%
0.00	2.8%	2.8%	0.00	2.8%	2.8%	0.00	2.8%	2.8%
0.00	17.7%	17.7%	0.00	17.7%	17.7%	0.00	17.7%	17.7%
0.00	2.6%	5.9%	0.00	2.6%	5.9%	0.00	2.6%	5.9%
13.44	19.9%	19.9%	1.51	19.7%	19.7%	13.44	19.9%	19.9%
0.00	10.1%	13.9%	0.00	10.1%	13.9%	0.00	10.1%	13.9%
13.85	18.7%	18.7%	11.90	18.7%	18.7%	0.94	18.6%	18.6%
8.51	18.2%	18.2%	6.27	18.2%	18.2%	0.89	18.1%	18.1%
3.24	31.6%	31.6%	3.24	31.6%	31.6%	3.24	31.6%	31.6%
1.51	11.3%	11.3%	1.51	11.3%	11.3%	1.51	11.3%	11.3%
22.01	5.6%	5.6%	12.34	5.4%	5.4%	9.97	5.4%	5.4%
15.73	13.2%	13.2%	15.73	13.2%	13.2%	10.42	13.0%	13.0%
9.51	5.3%	5.3%	8.00	5.2%	5.2%	8.00	5.2%	5.2%
0.00	21.7%	21.7%	0.00	21.7%	21.7%	0.00	21.7%	21.7%
0.00	5.2%	5.2%	0.00	5.2%	5.2%	0.00	5.2%	5.2%
0.00	14.9%	14.9%	0.00	14.9%	14.9%	0.00	14.9%	14.9%
0.00	32.8%	32.8%	0.00	32.8%	32.8%	0.00	32.8%	32.8%
0.00	56.0%	56.0%	0.00	56.0%	56.0%	0.00	56.0%	56.0%
4.22	23.0%	23.0%	2.00	23.0%	23.0%	1.48	23.0%	23.0%
23.70	18.5%	18.5%	5.81	17.9%	17.9%	11.25	18.1%	18.1%
7.97	21.3%	21.3%	3.86	21.2%	21.2%	7.97	21.3%	21.3%
0.00	26.4%	26.4%	0.00	26.4%	26.4%	0.00	26.4%	26.4%
0.00	18.0%	18.0%	0.00	18.0%	18.0%	0.00	18.0%	18.0%
1.51	25.7%	25.7%	1.51	25.7%	25.7%	1.51	25.7%	25.7%
1.87	6.3%	6.3%	1.87	6.3%	6.3%	1.87	6.3%	6.3%
0.74	2.1%	2.1%	0.74	2.1%	2.1%	0.74	2.1%	2.1%
0.00	5.1%	5.1%	0.00	5.1%	5.1%	0.00	5.1%	5.1%
0.00	2.2%	2.2%	0.00	2.2%	2.2%	0.00	2.2%	2.2%
3.25	3.7%	3.7%	3.25	3.7%	3.7%	0.58	3.7%	3.7%
4.51	19.7%	19.7%	4.28	19.7%	19.7%	1.49	19.6%	19.6%
2.33	43.5%	43.5%	0.06	43.5%	43.5%	0.81	43.5%	43.5%

0.00	20.7%	20.7%	0.00	20.7%	20.7%	0.00	20.7%	20.7%
0.00	4.3%	4.3%	0.00	4.3%	4.3%	0.00	4.3%	4.3%
0.00	13.3%	13.3%	0.00	13.3%	13.3%	0.00	13.3%	13.3%
0.00	34.1%	34.1%	0.00	34.1%	34.1%	0.00	34.1%	34.1%
0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
0.00	13.7%	13.7%	0.00	13.7%	13.7%	0.00	13.7%	13.7%
0.00	0.2%	0.2%	0.00	0.2%	0.2%	0.00	0.2%	0.2%
11.12	31.9%	31.9%	9.22	31.8%	31.8%	3.21	31.8%	31.8%
1.51	41.3%	41.3%	1.51	41.3%	41.3%	1.51	41.3%	41.3%
0.00	0.0%	1.5%	0.00	0.0%	1.5%	0.00	0.0%	1.5%
0.00	0.1%	15.1%	0.00	0.1%	15.1%	0.00	0.1%	15.1%
0.00	16.0%	16.0%	0.00	16.0%	16.0%	0.00	16.0%	16.0%

Appendix C – Duration of Elevated Risk

Table 6: Duration of elevated landslide risk due to the wildfire for all alternatives.

HUC_14	HU_14_NAME	percent high and moderate	Alt. 2 Percent High and Moderate NOT Planted	Duration of Elevatated Risk Alt 2.	Alt. 3 Percent High and Moderate NOT Planted	Duration of Elevatated Risk Alt 3.	Alt. 4 Percent High and Moderate NOT Planted	Duration of Elevatated Risk Alt 4.	Alt. 5 Percent High and Moderate NOT Planted	Duration of Elevatated Risk Alt 5.
18010206080302	Lumgrey Creek	2.5%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010206080304	Miller Gulch-Klamath River	21.5%	100.0%	80 years	100.0%	80 years	100.0%	80 years	100.0%	80 years
18010206090203	Soda Creek-Beaver Creek	7.9%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010206090301	Jaynes Canyon	0.1%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010206090304	Lower West Fork Beaver Creek	0.8%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010206090401	Dutch Creek	37.7%	93.5%	80 years	100.0%	80 years	94.6%	80 years	94.6%	80 years
18010206090402	Buckhorn Gulch-Beaver Creek	64.8%	99.4%	80 years	100.0%	80 years	99.5%	80 years	99.5%	80 years
18010206100202	Quigleys Cove-Klamath River	29.1%	95.7%	80 years	100.0%	80 years	97.0%	80 years	97.0%	80 years
18010206100301	Doggett Creek	32.1%	87.9%	80 years	100.0%	80 years	91.2%	80 years	91.2%	80 years
18010206100303	Dona Creek-Klamath River	28.5%	85.0%	80 years	100.0%	80 years	87.1%	80 years	87.1%	80 years
18010206100406	Buckhorn Creek	5.6%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010206100501	Kohl Creek	68.8%	98.0%	80 years	100.0%	80 years	98.5%	80 years	98.5%	80 years
18010206100502	Collins Creek-Klamath River	13.8%	100.0%	80 years	100.0%	80 years	100.0%	80 years	100.0%	80 years
18010206110101	Upper Grider Creek	35.2%	75.8%	50 years	75.8%	50 years	76.8%	80 years	76.8%	80 years
18010206110102	Cliff Valley Creek	24.6%	62.1%	50 years	63.5%	50 years	72.1%	50 years	72.1%	50 years
18010206110103	Rancheria Creek	64.3%	99.4%	80 years	99.4%	80 years	99.8%	80 years	99.8%	80 years
18010206110104	Lower Grider Creek	58.4%	69.9%	50 years	72.7%	50 years	76.7%	80 years	76.7%	80 years
18010206110301	Tom Martin Creek-Klamath River	39.3%	85.5%	80 years	85.7%	80 years	89.4%	80 years	89.4%	80 years
18010206110303	O'Neil Creek	42.7%	58.4%	50 years	58.4%	50 years	68.5%	50 years	68.5%	50 years
18010206110304	Schutts Gulch-Klamath River	9.1%	44.3%	2-5 years	44.3%	2-5 years	57.1%	2-5 years	57.1%	2-5 years
18010206110305	Walker Creek	40.1%	44.7%	50 years	46.8%	50 years	56.7%	50 years	56.7%	50 years
18010206110306	Caroline Creek-Klamath River	22.6%	5.5%	50 years	10.5%	50 years	47.1%	50 years	47.1%	50 years
18010206110307	West Grider Creek-Klamath River	1.1%	97.5%	2-5 years	97.5%	2-5 years	99.0%	2-5 years	99.0%	2-5 years
18010208020301	Upper French Creek	1.3%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010208020402	Sugar Creek	0.0%	0.0%	2-5 years	0.0%	2-5 years	0.0%	2-5 years	0.0%	2-5 years
18010208060101	Upper Canyon Creek	0.1%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010208060301	North Fork Kelsey Creek	31.1%	100.0%	80 years	100.0%	80 years	100.0%	80 years	100.0%	80 years
18010208060302	South Fork Kelsey Creek	2.8%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years

18010208060401	Middle Creek	28.2%	68.3%	50 years	69.7%	50 years	74.7%	50 years	74.7%	50 years
18010208060402	Deep Creek-Scott River	12.2%	97.6%	80 years	97.6%	80 years	98.8%	80 years	98.8%	80 years
18010208060403	Tompkins Creek	28.7%	76.8%	80 years	77.8%	80 years	81.7%	80 years	81.7%	80 years
18010208060601	McCarthy Creek-Scott River	22.9%	90.2%	80 years	90.2%	80 years	92.2%	80 years	92.2%	80 years
18010208060602	Big Ferry-Swanson	19.5%	94.0%	80 years	94.0%	80 years	95.1%	80 years	95.1%	80 years
18010208060603	Franklin Gulch-Scott River	16.4%	94.8%	80 years	94.8%	80 years	96.6%	80 years	96.6%	80 years
18010209020302	China Creek	8.1%	85.5%	2-5 years	87.4%	2-5 years	92.7%	2-5 years	92.7%	2-5 years
18010209020303	Horse Creek	22.3%	72.0%	50 years	97.8%	80 years	85.8%	80 years	85.8%	80 years
18010209020305	Fryingpan Creek-Klamath River	9.1%	87.6%	2-5 years	93.9%	2-5 years	93.4%	2-5 years	93.4%	2-5 years
18010209030101	Headwaters Elk Creek	43.5%	100.0%	80 years	100.0%	80 years	100.0%	80 years	100.0%	80 years
18010209030102	Rainy Valley Creek	10.6%	100.0%	80 years	100.0%	80 years	100.0%	80 years	100.0%	80 years
18010209030103	Toms Valley Creek-Elk Creek	24.6%	100.0%	80 years	100.0%	80 years	100.0%	80 years	100.0%	80 years
18010209030104	Granite Creek	0.0%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010209030105	Middle Elk Creek	7.0%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010209030201	Upper East Fork Elk Creek	35.4%	97.1%	80 years	100.0%	80 years	98.8%	80 years	98.8%	80 years
18010209030202	Upper Elk Creek	28.1%	71.3%	50 years	75.1%	50 years	82.4%	80 years	82.4%	80 years
18010209030203	Lower East Fork Elk Creek	34.8%	80.4%	80 years	80.8%	80 years	91.3%	80 years	91.3%	80 years
18010209030301	Bear Creek	16.5%	100.0%	80 years	100.0%	80 years	100.0%	80 years	100.0%	80 years
18010209030302	Bishop Creek-Elk Creek	0.0%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010209030303	Doolittle Creek	18.8%	96.0%	80 years	97.8%	80 years	97.8%	80 years	97.8%	80 years
18010209030304	Cougar Creek-Elk Creek	9.1%	91.7%	2-5 years	96.7%	2-5 years	98.4%	2-5 years	98.4%	2-5 years
18010209030305	Hoop&Devil-Elk Creek	5.2%	81.1%	2-5 years	87.1%	2-5 years	97.8%	2-5 years	97.8%	2-5 years
18010209060103	Benjamin Creek-Klamath River	0.0%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010210010304	Sixmile Creek	2.5%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010210010306	Shadow Creek	1.0%	99.8%	2-5 years	99.8%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010210020301	Upper South Russian Creek	22.3%	98.9%	80 years	98.9%	80 years	99.5%	80 years	99.5%	80 years
18010210020302	Music Creek	46.7%	89.5%	80 years	89.5%	80 years	91.0%	80 years	91.0%	80 years
18010210020303	Lower South Russian Creek	22.3%	100.0%	80 years	100.0%	80 years	100.0%	80 years	100.0%	80 years
18010210020401	Upper North Russian Creek	4.5%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010210020402	Taylor Creek	14.5%	98.1%	80 years	98.1%	80 years	98.8%	80 years	98.8%	80 years
18010210020403	Lower North Russian Creek	35.2%	97.2%	80 years	97.2%	80 years	98.3%	80 years	98.3%	80 years
18010210020502	Big Creek	0.0%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010210020503	Yellow Dog Creek-North Fork Salmon River	14.3%	100.0%	80 years	100.0%	80 years	100.0%	80 years	100.0%	80 years
18010210020603	Specimen Creek	0.1%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010210020701	Whites Gulch	33.5%	84.9%	80 years	86.8%	80 years	88.6%	80 years	88.6%	80 years
18010210020702	Robinson Gulch-North Fork Salmon River	42.1%	97.0%	80 years	97.0%	80 years	97.9%	80 years	97.9%	80 years
18010210020703	Eddy Gulch	0.0%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010210020704	Jessups Gulch-North Fork Salmon River	0.1%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years
18010210020705	Jackass Gulch	1.1%	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years	100.0%	2-5 years

Appendix D – Summary of Alternative Effects on Landslide Risk and Duration of Elevated Risk

Table 7: Summary of effects on measures for landslide risk and duration of elevated risk results for all action alternatives.

7th Field Watershed Name	Current Landslide Risk	Change in Risk Ratio for All Action Alternative	Change in percent Disturbed for Alt. 2	Alternative 2 Duration of Elevated Risk	Change in Percent Disturbance Alt 3	Alternative 3 Duration of Elevated Risk	Change in Percent Disturbance Alt 4	Alt 4 Duration of Elevated Risk	Change in Percent Disturbance Alt. 5	Alt. 5 Duration of Elevated Risk
Dutch Creek	Moderate	0.03	0.2	>80 years	0.2	>80 years	0.01	>80 years	0.01	>80 years
Buckhorn Gulch	High	0.01	0.1	>80 years	0.1	>80 years	0.0	>80 years	0.0	>80 years
Quigleys Cove	Moderate	0.04	0.1	>80 years	0.1	>80 years	0.1	>80 years	0.1	>80 years
Doggett Creek	high	0.04	0.1	>80 years	0.1	>80 years	0.1	>80 years	0.1	>80 years
Dona Creek	Moderate	0.04	0.0	>80 years	0.0	>80 years	0.0	>80 years	0.0	>80 years
Kohl Creek	High	0.01	0.1	>80 years	0.1	>80 years	0.1	>80 years	0.0	>80 years
Upper Grider Creek	High	0.04	0.2	30 years	0.2	30 years	0.2	>80 years	0.2	>80 years
Cliff Valley	High	0.01	0.3	30 years	0.3	30 years	0.0	30 years	0.1	30 years
Lower Grider Creek	Very High	0.02	0.3	30 years	0.3	30 years	0.2	>80 years	0.2	>80 years
Tom Martin Creek	High	0.01	0.1	>80 years	0.1	>80 years	0.1	>80 years	0.1	>80 years
ONeil Creek	High	0.01	0.5	30 years	0.5	30 years	0.3	30 years	0.4	30 years
Walker Creek	Very High	0.03	0.2	30 years	0.2	30 years	0.1	30 years	0.1	30 years
Caroline Creek	High	0.03	1.1	30 years	1.1	30 years	0.4	30 years	1.1	30 years
Middle Creek	Moderate	0.11	0.3	30 years	0.3	30 years	0.1	30 years	0.3	30 years
Tompkins Creek	Moderate	0.01	0.1	>80 years	0.1	>80 years	0.1	>80 years	0.0	>80 years
McCarthy Creek	Moderate	0.0	0.1	>80 years	0.1	>80 years	0.1	>80 years	0.0	>80 years
Big Ferry-Swanson	High	0.0	0.1	>80 years	0.1	>80 years	0.1	>80 years	0.1	>80 years
China Creek	Moderate	0.02	0.4	>80 years	0.4	>80 years	0.2	>80 years	0.2	>80 years
Horse Creek	Moderate	0.09	0.7	30 years	0.7	>80 years	0.7	>80 years	0.5	>80 years
Fryingpan Creek	Moderate	0.0	0.2	>80 years	0.2	>80 years	0.1	>80 years	0.1	>80 years
Upper East Fork Elk	Moderate	-0.04	0.1	>80 years	0.1	>80 years	0.1	>80 years	0.1	>80 years
Upper Elk Creek	Moderate	-0.01	0.8	30 years	0.8	30 years	0.2	>80 years	0.4	>80 years
Lower East Fork Elk	Moderate	-0.05	0.2	>80 years	0.2	>80 years	0.1	>80 years	0.2	>80 years
Doolittle Creek	High	-0.02	0.0	>80 years	0.0	>80 years	0.0	>80 years	0.0	>80 years
Cougar Creek	Moderate	-0.04	0.0	>80 years	0.0	>80 years	0.0	>80 years	0.0	>80 years
Hoop and Devil	Moderate	-0.02	0.0	>80 years	0.0	>80 years	0.0	>80 years	0.0	>80 years
Upper South Russian Creek	Low	0.0	0.1	>80 years	0.1	>80 years	0.1	>80 years	0.0	>80 years
Whites Gulch	High	0.0	0.2	>80 years	0.2	>80 years	0.1	>80 years	0.1	>80 years
Average Change		0.01	0.24		0.24		0.13		0.16	