United States
Department of
Agriculture

Forest
Service

July 2015

Amendment to the Soil Report

Westside Fire Recovery Project

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

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I. Summary of Modifications between Draft and Final EIS

Changes made to the soils analysis between the draft and final include the following:

- The affected environment and environmental effects have been separately displayed for the 3 fire-identified project areas to account for differences among the Beaver fire, Happy Camp Complex, and Whites fire.
- The effects analysis has been changed to account for the spatial overlap of proposed harvest and site preparation treatments. The overlap of ground based harvest and mechanical site preparation would result in an addition 10 percent area that would not meet soil stability and soil organic matter indicators compared to ground based harvest only. The project design was changed to retain more soil cover during site preparation and limit soil impacts beyond the 10 percent increase. In addition, mechanized harvest using feller bunchers has been proposed to complete ground based harvest. Compared to conventional harvest methods, mechanized harvest would result in an additional 5 to 10 percent area that would not meet the soil stability indicator.
- Alternative 1 describes the existing condition and quantifies the area not meeting soil indicators. Alternatives 2 through 5 quantifies the area that would not met soil indicators due to proposed activities. Impacts from proposed activities could occur on some of the same areas as the existing condition, yet to predict a worst case scenario the impacts associated with the action alternatives must be added to those under the no action alternative.
- The acres that do not meet desired condition in this amendment are the sum of the acres not currently meeting desired conditions (alternative 1) and the acres affected by the alternative. So the direct and indirect effects of the alternative are the alternative 1 acres minus the action alternative acres.
- The soil stability indicator has been revised so that desired conditions would not be met when Erosion Hazard Ratings are high or when soil cover is less than the values listed in Table 1 (Forest Plan Standard and Guideline 4-2).

Table 1: Soil Cover Guidelines for Vegetation and Fuels Management Projects (USDA, 2010)

Soil Cover Guidelines for Projects		
Soil Texture Class	**Slope (%)**	**Minimum Total Soil Cover* (%)**
Guidelines for Projects Using Tractors:		
Sandy loam or coarser	0-25	70
	26-35	80
Loam or finer	0-35	70
Guidelines for Prescribed Burning Projects:		
Sandy loam or coarser	0-25	60
	26-45	70
	46	80
Loam or finer	0-35	50
	36-60	60
	61	70

II. Environmental Consequences of Modified Alternatives

Modified Alternative 2

Project Area A: Beaver Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Beaver Fire area, erosion rates were modeled at an average of 4 tons per acre (range 0 to 22 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 1,224 acres or 17 percent of the fire project area would temporarily not meet the soil stability indicator. This disturbance area was calculated using the following formula which applies to all alternatives where these activities are proposed:

(100% x new landing acres) + (50% x existing landing acres) + (100% x new temp rd acres) + (100% x reopen decommissioned rd acres) + (75% x existing temp rd acres) + (5% x fuel break mechanical or hand acres) + (2% x hand thin pile burn acres) + (8% x machine pile burn fuels acres) + (15% x mastication or mechanical thin fuels acres) + (8% x machine pile burn fuels acres) + (15% x ridgetop fuels acres) + (10% x roadside fuels acres) + (2% x underburn acres) + (2% x understory thin, pile burn acres) + (10% x cable yard, plant acres) + (1% x handcut and

pile burn, plant acres) + (2% x masticate acres) + (10% x masticate and subsoil, plant acres) + (1% x masticate, plant acres) + (15% x mechanical thin, pile burn, plant acres) + (20% x mechanical thin and pile, subsoil acres) + (40% x roadside ground based harvest acres) + (5% x roadside aerial harvest acres) + (35% x groundbased, hand pile, pile burn acres) + (10% x skyline harvest, hand pile, pile burn acres) + (10% x machine pile burn fuels acres) + (1% x helicopter harvest, hand pile, pile burn acres) + (15% x helicopter, machine pile, pile burn acres) = **2,054 acres affected for Alternative 2 Beaver Fire area – 5 acres currently not meeting desired condition = 2,049 acres affected by proposed project activities**

For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Mulching is generally the most effective treatment in reducing post-fire runoff and erosion (Robichaud, 2013). Compared to undisturbed areas, ground based harvest would result in approximately 20 to 30 times higher sediment yields on compacted, mulched areas, however at the watershed scale, surface runoff and sediment would be trapped, leading to localized deposition and a lower sediment yield per unit area. Rapid vegetation regrowth is expected on undisturbed areas and this would reduce the potential for this sediment to be delivered to the stream network (Wagenbrenner, 2014). Tractor harvest would therefore have a shorter-term effect on larger-scale runoff.

During site preparation, manual felling of small diameter trees could also be accomplished to add soil cover on ground based harvest units. Project design feature watershed-11 would require site preparation to maintain adequate soil cover to maintain soil stability by not reducing the sum of 1, 10, and 100 hour fuels to less than less than 7 tons per acre.

Project design features have been revised to require decompacting soils on new temporary roads to varying depths based on their surface texture and slope. This would improve infiltration and permeability, while avoiding greater impacts to soil stability and soil organic matter. To speed the recovery of soil cover on new temp roads, a PDF would require maintaining at least 50 percent effective soil cover.

With the application of these measures it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

Approximately 413 acres or 6 percent may not meet the desired condition for surface organic matter due to insufficient retention of large woody material.

Soil Organic Matter

Approximately 820 acres, or 11 percent of the activity area, may not meet the desired condition for SOM due to mechanical disturbance which could result in the displacement of SOM. In addition the removal of soil cover could result in accelerated erosion and therefore impact SOM. This disturbance area was calculated using the following formula which applies to all alternatives where these activities are proposed:

> (100% x new landing acres) + (0% x existing landing acres) + (100% x new temp rd acres) + (0% x reopen decommissioned rd acres) + (0% x existing temp rd acres) + (5% x fuel break mechanical or hand acres) + (2% x hand thin pile burn acres) + (8% x machine pile burn fuels acres) + (15% x mastication or mechanical thin fuels acres) + (8% x machine pile burn fuels acres) + (15% x ridgetop fuels acres) + (10% x roadside fuels acres) + (2% x underburn acres) + (2% x understory thin, pile burn acres) + (10% x cable yard, plant acres) + (1% x handcut and pile burn, plant acres) + (2% x masticate acres) + (10% x masticate and subsoil, plant acres) + (1% x masticate, plant acres) + (15% x mechanical thin, pile burn, plant acres) + (20% x mechanical thin and pile, subsoil acres) + (40% x roadside ground based harvest acres) + (5% x roadside aerial harvest acres) + (35% x groundbased, hand pile, pile burn acres) + (10% x skyline harvest, hand pile, pile burn acres) + (10% x machine pile burn fuels acres) + (1% x helicopter harvest, hand pile, pile burn acres) + (15% x helicopter, machine pile, pile burn acres) = **956 acres affected for Alternative 2 Beaver Fire area – 573 acres currently not meeting desired condition = 383 acres affected by proposed project activities**

Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually due to accelerated erosion. Accelerated erosion would be expected where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter. Mechanical displacement would occur mainly due to the construction of temporary roads, landings, and skid trails, and to a lesser extent from feller bunchers operating off of skid trails. It is anticipated that SOM would not meet desired conditions on approximately 20 percent of units proposed for both ground based harvest and mechanical fuel reduction or site preparation, 15 percent of ground based harvest units, 10 percent of skyline units, and less than 1 percent of proposed helicopter units. The most severe displacement of SOM is expected to occur during temporary road construction and on landings and main skid trails. Temporary road construction would result in the highest impacts to SOM, especially on steeper side slopes which would require excavation of a cut slope. Ground based skid trails would result in displacement of SOM on skidder tracks, and where yarded trees dig into the mineral soil surface and wedge the surface to the side. This creates berms and piles along the edges of skid trails. Soil disturbance is greater on steeper slopes, and a PDF would limit

ground based skidding to slopes less than 35 percent or short pitches of 100 feet on slopes less than 45 percent. Displacement caused by new skid trails and temporary road construction will be considered a long-term disturbance as no mitigations to replace displaced SOM are planned. Approximately 20 percent of the proposed ground based units have forest survey site class ratings of 4 and 5, which are lower productivity on a scale of 1 to 7. On these more sensitive soils, fewer passes of mechanical equipment could result in detrimental impacts to soil organic matter and soil productivity.

On proposed harvest units, jackpot pile burning would be expected to produce enough heat to consume SOM within the footprint of the piles.

With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 432 acres or 6 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area B: Happy Camp Complex

Direct Effects and Indirect Effects

Soil Stability

The effects to soil resources affected by the alternative are the same as described for the Beaver Fire area and would occur over the same percentages of those proposed actions. Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Happy Camp Fire area, erosion rates were modeled at an average of 67 tons per acre (range 18 to 103 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 2,634 acres or 9 percent of the fire project area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Happy Camp Fire of 18 to 109 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features have been revised to require decompacting soils on new temporary roads to varying depths based on their surface texture and slope. This would improve infiltration and permeability, while avoiding greater impacts to soil stability and soil organic matter. To speed the recovery of soil cover on new temp roads, a PDF would require maintaining at least 50 percent effective soil cover.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material

could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 2,740 acres or 9 percent may not meet the desired condition for SOM due to to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter. In addition the removal of soil cover could result in accelerated erosion and therefore impact SOM.

With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 1,720 acres or 6 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area B: Whites Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher

additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Whites Fire area, erosion rates were modeled at an average of 13 tons per acre for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 799 acres or 7 percent of the fire project area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff.

Project design features have been revised to require decompacting soils on new temporary roads to varying depths based on their surface texture and slope. This would improve infiltration and permeability, while avoiding greater impacts to soil stability and soil organic matter. To speed the recovery of soil cover on new temp roads, a PDF would require maintaining at least 50 percent effective soil cover.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of

an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

Soil Organic Matter

Approximately 665 acres or 5 percent may not meet the desired condition for SOM due to to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter. In addition the removal of soil cover could result in accelerated erosion and therefore impact SOM.

Soil Structure

The effects to soil resources affected by the alternative are the same as described in the Beaver Fire area. It is expected soil structure would not meet desired conditions on approximately 351 acres or 3 percent of the Whites fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Summary of Effects

As described in the DEIS, the greatest impact to soil quality would likely occur due to mechanical activities that result in bare soil and compact the soil surface, resulting in impacts to soil stability. In a fire affected environment, these can result in long term impacts to soil productivity because the return of vegetation can be delayed and rates of accelerated erosion are higher on compacted, bare soils. This condition may not stabilize for 5 to 10 years until planted trees or brush provide soil cover.

Ground based equipment is proposed on the greatest percentage area within the Beaver fire area, followed by the Happy Camp, than Whites fire area. Although ground based equipment is proposed on the greatest area within the Happy Camp complex, this fire area has a large percentage of aerial harvest treatment and additional fuels and site preparation treatments that do not propose use of heavy equipment. Therefore, when averaged over the entire Happy Camp fire area, soil stability would not meet desired conditions on approximately 7 percent compared to between 16 to 18 percent within the Beaver Fire area.

In addition to impacting soil productivity, impacts to soil stability could result in accelerated erosion and impacts to beneficial uses. This depends on factors such as precipitation, slope, and soil types. Compared to historical data, the three fire areas have received less precipitation during the past several years. However, precipitation events have been warmer with more rain compared to snow, and occur at higher intensities. Due to climate change, the Happy Camp and Whites fire areas are more susceptible to higher rates of accelerated erosion compared to the lower Beaver Fire area which typically receives less snow.

Factors such as precipitation, slope, and soil type are reflected in the soil erosion modeling that was completed for the BAER soils reports of the three fire areas. The Happy Camp BAER Soils Report used ERMIT to predict considerably higher rates of accelerated erosion compared to the Whites and Beaver Fire areas. These rates of accelerated erosion have slowly begun to stabilize

but indicate the potential for higher impacts within the Happy Camp fire area where proposed activities result in bare and compacted soil.

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

There are no changes to compliance with law, regulation, policy, and the Forest Plan compared to the DEIS.

Modified Alternative 3

Project Area A: Beaver Fire

Direct Effects and Indirect Effects

Soil Stability

Compared to alternative 2, long term accelerated erosion is much less likely to continue downslope of treatments proposed in the Beaver Fire analysis area because ground based harvest is only proposed as a site preparation treatment. This treatment would not use mortality guidelines and therefore retention of more trees would result in more potential soil cover. Half of the impacts to soil stability would occur due to ground based roadside hazard treatments, and half due to the sum of site preparation and fuels reduction activities. Ground based roadside hazard would occur on short lengths of less than 250 feet. At these shorter lengths, lower rates of accelerated erosion would be expected, and further downslope transport of eroded soil is unlikely.

Project design features have been revised to require decompacting soils to varying depths based on their surface texture and slope. This would improve infiltration and permeability, while avoiding greater impacts to soil stability and soil organic matter. A PDF would require maintaining at least 50 percent effective soil cover on new temporary roads. By design, fuels reduction treatments would retain soil cover to meet LMP soil cover standards. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability. For these reasons, its likely soil stability desired conditions on site preparation and fuels reduction treatments would return to acceptable levels in less than five years.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. However, compared to alternative 2, these levels are expected to last a shorter time and impacted a smaller area. For the total Beaver Fire area, erosion rates were modeled at an average of 4 tons per acre (range 0 to 22 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. An estimated 910 acres or 16 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. With the application of measures described above, it is expected the soil

stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

The surface organic matter indicator would be met or partially met on all treatment areas because there is no salvage in the Beaver fire area. Ground based roadside hazard treatment would be expected to remove the highest amounts of surface organic matter and partially impact Surface Organic Matter desired conditions. This would occur over on areas less than 500 feet wide, and adjacent areas would contribute large woody debris to provide nutrients and habitat for soil microorganisms. This is a major decrease in impacts compared to alternative 2.

Soil Organic Matter

Compared to Alternative 2, impacts to soil organic matter would occur over a smaller area and less likely to impact long term productivity. Approximately 906 acres or 16 percent may not meet the desired condition for SOM due to to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.

As described in the soil stability paragraph, desired conditions are likely to return to acceptable levels within the short term. Therefore, although SOM may be displaced due to mechanical disturbance, it is more likely to remain on site and not permanently lost due to accelerated erosion.

Underburning is proposed on 1,431 acres that burned with low SBS. If a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 453 acres or 6 percent of the fire area. Compared to alternative 2, impacts to soil structure are not expected to impact biomass productivity because soils have a moderate compaction rating and compaction deeper than approximately 6 inches is not expected. Rather, the infiltration and permeability capacity of the soil would be impacted over the short term. Widespread, long term impacts are less likely because, as described in the soil stability indicator above, soil cover is predicted to recover in the short term on fuels and site preparation treatments. Decreased accelerated erosion would promote the recovery of soil cover, vegetation regrowth, and therefore the infiltration and permeability capacity of the soil. This is less likely to occur where ground based harvest of hazard trees results in compaction in areas with insufficient cover.

Cumulative Effects

Effects from grazing are as discussed under alternative 1. Adding these effects to the effects of alternative 2 will not result in measurable cumulative effects.

Project Area B: Happy Camp Complex

Direct Effects and Indirect Effects

Soil Stability

An estimated 2,198 or 16 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. Effects to soil stability within the Happy Camp Complex analysis area would be slightly less than those described under the modified Alternative 2 mainly because fewer acres of ground based harvest are proposed. Ground based harvest as a site preparation treatment would not use mortality guidelines and therefore retention of more trees would result in more potential soil cover.

Project design features have been revised to require decompacting soils on new temporary roads to varying depths based on their surface texture and slope. This would improve infiltration and permeability, while avoiding greater impacts to soil stability and soil organic matter. To speed the recovery of soil cover on new temp roads, a PDF would require maintaining at least 50 percent effective soil cover.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

Underburning is proposed on 1,415 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the soil burn severity (SBS) of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Organic Matter

Compared to Alternative 2, slightly less area would not meet the soil organic matter indicator. Approximately 2,317 acres or 9 percent may not meet the desired condition for SOM due to mechanical disturbance which could result in the displacement of SOM. In addition the removal of soil cover could result in accelerated erosion and therefore impact SOM.

Soil Structure

Compared to Alternative 2, soil structure desired conditions would not be met on 72 fewer acres, approximately 1,237 acres, or 5 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area C: Whites Fire

Direct Effects and Indirect Effects

Soil Stability

Effects to soil stability within the Whites fire analysis area would be slightly less than those described under the modified Alternative 2. Ground based harvest as a site preparation treatment would not use mortality guidelines and therefore retention of more trees would result in more potential soil cover.

An estimated 723 acres or 6 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met.

Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Happy Camp Fire of 18 to 109 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion.

Project design features have been revised to require decompacting soils to varying depths based on their surface texture and slope. This would improve infiltration and permeability, while avoiding greater impacts to soil stability and soil organic matter. To speed the recovery of soil cover on new temp roads, a PDF would require maintaining at least 50 percent effective soil cover.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

Underburning is proposed on 5,352 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Organic Matter

Compared to Alternative 2, less area would not meet the soil organic matter indicator. Approximately 449 acres or 5 percent may not meet the desired condition for SOM due to

mechanical disturbance which could result in the displacement of SOM. In addition the removal of soil cover could result in accelerated erosion and therefore impact SOM.

With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Soil Structure

Compared to Alternative 2, soil structure desired conditions would not be met on 16 fewer acres, approximately 335 acres, or 3 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Summary of Effects

Compared to Alternative 2, impacts within the Beaver fire area would be greatly reduced and areas not meeting soil desired conditions would be expected to recover more quickly. Soil impacts would also be reduced within the Happy Camp and Whites Fire area because of slight reductions in proposed harvest treatments, revisions to PDFs, and the change in project design to not use mortality guidelines during site preparation ground based harvest.

Compliant with Law, Policy and the Forest Plan

There are no changes to compliance with law, regulation, policy, and the Forest Plan compared to the DEIS.

III. Modification of Environmental Consequences by Fire Area since the Draft EIS

Affected Environment

Project Area A: Beaver Fire

Soils within the Beaver Fire analysis area consist mostly of Holland, Skalan, Clallam, and Lithic Haploxeralfs (Table 2). These soil types are derived mainly from granitic rock, metamorphic rock, or ultramafic rock such as serpentine. Soil textures vary from loam to sandy loam with high percentages of rock fragments.

Table 2: Soil families and associated properties used in analysis

Family	Acres	Surface Texture	Soil Depth, inches	Compaction Hazard
Beaughton	1023	Gravelly loam	10-20	Moderate
Blusprin	786	Very cobbly loam	20-40	Moderate
Clallam	3190	Gravelly ashy sandy loam	40-60	Moderate
Coboc	1208	Gravelly loam	40-60	Moderate
Dubakella	721	Stony loam	20-40	Moderate
Holland	7773	Sandy loam	60+	Moderate
Kang	1705	Gravelly sandy clay loam	20-40	Moderate
Lithic Haploxeralfs	3299	----------	-------	----------
Skalan	6612	Gravelly ashy loam	<30	Moderate
Weitchpec	1097	Gravelly sandy loam	20-40	Moderate

Soil Stability

Currently, 5 acres of the Beaver fire project area does not meet desired conditions for soil stability (see Table 3). Compared to the Happy Camp and Whites Fire areas, slopes are more gradual on the Beaver Fire area and Erosion Hazard Ratings (EHR) are mostly moderate. EHRs were high on 30 acres, yet since the fire, soil cover has increased from the return of vegetation and dead needles. Therefore EHRs have been reduced to moderate on 25 acres, which partially meets the desired condition for soil stability.

Table 3: Area (acres) meeting desired condition

Indicator	Met	Partially met	Not met
1. Acres not meeting desired conditions for soil stability	4,745	1,446	5
2. Acres not meeting desired conditions for surface matter	6,196	0	0
3. Acres not meeting desired conditions for soil organic matter	3,708	1,915	573
4. Acres not meeting desired conditions for soil structure	5,838	89	269

Surface Organic Matter

Surface organic matter is currently limited in severely burned areas but will recover as dead trees fall and leaf litter from early seral plant communities accumulates. All of the project area is meeting the desired condition for surface organic matter. Although many areas of the project have less than 200 cubic feet per acre of large woody debris, there is a high volume of standing dead trees, greater than 12 inch diameter.

Soil Organic Matter

The current condition is that approximately 573 acres of the project area are not meeting desired conditions for soil organic matter because the Beaver Fire resulted in high Soil Burn Severity (SBS). Moderate SBS occurred on 1,915 acres and this partially meets the desired condition for

soil organic matter. Low or very low soil burn severity occurred on 3,257 acres and this meets the desired condition.

Soil Structure

It's estimated approximately 269 acres of the project area are not meeting desired conditions for soil structure and 89 acres partially meet the desired condition for soil structure. This is based on the area disturbed by mechanical equipment during the last 30 years.

Project Area B: Happy Camp Complex

Soils within the Happy Camp Fire area consist mostly of Clallam, Jayar, Woodseye, Gilligan, Deadwood and Skalan (Table 4). These soil types are derived mainly from metamorphic or granitic rock. Soil textures vary from loam to sandy loam with high percentages of rock fragments.

Table 4: Soil families and associated properties used in analysis

		Soil Properties used in Analysis		
Family	**Acres**	**Surface Texture**	**Soil Depth, inches**	**Compaction Hazard**
Buell	250	Gravelly loam	60+	Moderate
Chawanakee	2,868	Coarse sandy loam	<20	Moderate
Clallam	41,816	Gr ashy sandy loam	40-60	Moderate
Coboc	466	Gravelly loam	40-60	Moderate
Deadwood	7,300	Gr sandy loam	<20	Moderate
Dubakella	999	Stony loam	20-40	Moderate
Endlich	874	Very stony loam	20-40	Moderate
Entic Xerumbrepts	286	Gravelly loam	<20	Moderate
Gerle	572	Sandy loam	40-60	Moderate
Gilligan	8,949	Ashy silt loam	40-60+	Moderate
Goldridge	472	Fine sandy loam	60-80+	Moderate
Holland	4,151	Sandy loam	60+	Moderate
Jayar	12,174	V gr loam	<30	Moderate
Lithic Haploxeralfs	107	Loam	<20	Moderate
Lithic Ruptic	5,595	V gr loam	<20	Moderate
Nanny	530	Gravelly loam	30-60	Moderate
Olete	4,497	V gr silt loam	<20	Moderate
Parks	2,144	v gr sandy clay loam	40-60	Moderate
Rock	869	----------	-------	Low
Skalan	2,477	Gr ashy loam	<30	Moderate
Typic Haploxerolls	766	Gr Loam	20-40	Moderate
Weitchpec	201	Gravelly sandy loam	20-40	Moderate
Woodseye	9,302	V gr sandy loam	<20	Moderate

Soil Stability

Currently, approximately 633 acres of the project area are not meeting desired conditions for soil stability (see Table 5). The areas that are not meeting the desired condition have high EHRs due to recent wildfires which removed soil cover on steep slopes. Soil cover has remained deficient on this area because canopy cover was combusted and unavailable to provide soil cover. On 12,543 acres, EHRs were high, yet since the Happy Camp Fire, soil cover has increased from the return of vegetation and dead needles.

Table 5: Area (acres) meeting desired condition

Indicator	Met	Partially met	Not met
1. Acres not meeting desired conditions for soil stability	3,413	26,824	633
2. Acres not meeting desired conditions for surface matter	30,870	0	0
3. Acres not meeting desired conditions for soil organic matter	20,750	9,478	642
4. Acres not meeting desired conditions for soil structure	29,337	1,150	383

Surface Organic Matter

Surface organic matter is currently limited in severely burned areas but will recover as dead trees fall and leaf litter from early seral plant communities accumulates. All of the project analysis area is meeting the desired condition for surface organic matter. Although most of the project analysis area has less than 200 cubic feet per acre of large woody debris, there is a high volume of standing dead trees, greater than 12 inch diameter.

Soil Organic Matter

The current condition is that approximately 642 acres of the project area are not meeting desired conditions for soil organic matter because they have high SBS. Moderate SBS occurred on 9,478 acres and this partially meets the desired condition for soil organic matter. Low or very low soil burn severity occurred on 18,198 acres and this meets the desired condition.

Soil Structure

It's estimated approximately less than 383 acres of the project analysis area are not meeting desired conditions for soil structure. This is based on the area disturbed by mechanical equipment during the last 30 years.

Project Area C: Whites Fire

Soils within the Whites Fire area consist mostly of Clallam, Holland, Woodseye, Deadwood, Skalan, and Jayar (Table 6). These soil types are derived mainly from metamorphic or granitic rock. Soil textures vary from loam to sandy loam with high percentages of rock fragments.

Table 6: Soil families and associated properties used in analysis

		Soil Properties used in Analysis		
Family	**Acres**	**Surface Texture**	**Soil Depth, inches**	**Compaction Hazard**
Chawanakee	51	Coarse sandy loam	<20	Moderate
Clallam	10310	Gr ashy sandy loam	40-60	Moderate
Coboc	1182	Gravelly loam	40-60	Moderate
Deadwood	4049	Gr sandy loam	<20	Moderate
Endlich	1200	Very stony loam	20-40	Moderate
Entic Xerumbrepts	809	----------	--------	--------
Gerle	1618	Sandy loam	40-60	Moderate
Gilligan	377	Ashy silt loam	40-60+	Moderate

		Soil Properties used in Analysis		
Family	**Acres**	**Surface Texture**	**Soil Depth, inches**	**Compaction Hazard**
Holland	4214	Sandy loam	60+	Moderate
Jayar	2370	V gr loam	<30	Moderate
Kang	45	Gravelly sandy clay loam	20-40	Moderate
Lithic Xerumbrept	30	----------	--------	--------
Nanny	1835	Gravelly loam	30-60	Moderate
Rock	1414	----------	-------	--------
Skalan	2881	Gr ashy loam	<30	Moderate
Woodseye	4061	V gr sandy loam	<20	Moderate

Soil Stability

Currently, approximately 4,012 acres of the project analysis area are not meeting desired conditions for soil stability (see Table 7). The areas that are not meeting the desired condition have high EHRs due to recent wildfires which combusted organic matter on top of the soil surface. Soil cover has remained deficient on this area because canopy cover was combusted and unavailable to provide soil cover. On 20,545 acres, erosion hazard ratings were high, yet since the fires soil cover has increased from the return of vegetation and dead needles.

Table 7: Area (acres) meeting desired condition

Indicator	Met	Partially met	Not met
1. Acres not meeting desired conditions for soil stability	2,215	9,662	280
2. Acres not meeting desired conditions for surface matter	12,157	0	0
3. Acres not meeting desired conditions for soil organic matter	8,997	2,880	280
4. Acres not meeting desired conditions for soil structure	11,956	151	50

Soil Organic Matter

The current condition is that approximately 280 acres of the project analysis area are not meeting desired conditions for soil organic matter because they have high SBS. Moderate SBS occurred on 2,880 acres and this partially meets the desired condition for soil organic matter.

Surface Organic Matter

Surface organic matter is currently limited in severely burned areas but will recover as dead trees fall and leaf litter from early seral plant communities accumulates. All of the project analysis area is meeting the desired condition for surface organic matter. Although many areas of the project have less than 200 cubic feet per acre of large woody debris, there is a high volume of standing dead trees, greater than 12 inch diameter.

Soil Structure

It’s estimated approximately less than 151 acres of the project analysis area are not meeting desired conditions for soil structure.

Environmental Consequences

Alternative 1

Project Area A: Beaver Fire

The effects analysis for surface organic matter and soil organic matter would not change compared to the soil specialist report.

Direct Effects and Indirect Effects

Immediately following the 2014 fires, EHRs were high on approximately less than 1 percent of the project analysis area. Within one year following the fire, soil cover has increased on areas with low to moderate soil burn severities. Therefore EHRs have been reduced to moderate on 25 acres, which partially meets the desired condition for soil stability.

Soil cover is less likely to increase on 5 acres with high SBS because tree canopy has been consumed.

Based on the KNF facts GIS database, approximately 1,794 acres have been impacted by mechanical equipment during the past 30 years. It's been estimated based on soil textures and forest monitoring that approximately 5 percent, or 89 acres, of this area does not met desired conditions for soil structure because it likely has severe compaction and 15 percent, or 269 acres partially meets the desired condition because it has moderate levels of compaction.

Cumulative Effects

There would be no change in cumulative effects compared to the soil specialist report.

Project Area B: Happy Camp Complex

The effects analysis for surface organic matter and soil organic matter would not change compared to the soil specialist report.

Direct Effects and Indirect Effects

Immediately following the 2014 fires, EHRs were high on approximately 45 percent of the project analysis area. Within one year following the fire, soil cover would increase on areas with low to moderate soil burn severities. Soil cover is less likely to increase on areas with high SBS because tree canopy has been consumed. Therefore EHRs have been reduced to moderate on 280 acres, which partially meets the desired condition for soil stability. EHRs have remained high on 6,912 acres which do not met the desired condition for soil stability.

Based on the KNF facts GIS database, approximately 1,007 acres have been impacted by mechanical equipment during the past 30 years. It's been estimated based on soil textures and forest monitoring that approximately 5 percent, or 50 acres, of this area has severe compaction and 15 percent, or 150 acres has moderate levels of compaction.

Cumulative Effects

There would be no change in cumulative effects compared to the soil specialist report.

Project Area C: Whites Fire

Direct Effects and Indirect Effects

The effects analysis for surface organic matter and soil organic matter would not change compared to the soil specialist report.

Soil Stability

Immediately following the 2014 fires, EHRs were high on approximately 66 percent of the project analysis area. Within one year following the fire, soil cover would increase on areas with low to moderate soil burn severities. Soil cover is less likely to increase on areas with high SBS because tree canopy has been consumed. Therefore, areas with high EHRs would decrease to moderate. EHRs have remained high on 4,012 acres which do not met the desired condition for soil stability.

Soil Structure

Based on the KNF facts GIS database, approximately 1,794 acres have been impacted by mechanical equipment during the past 30 years. It's been estimated based on soil textures and forest monitoring that approximately 5 percent, or 89 acres, of this area has severe compaction and 15 percent, or 269 acres has moderate levels of compaction.

Cumulative Effects

There would be no change in cumulative effects compared to the soil specialist report.

Summary of Effects

Alternative 2

Project Area A: Beaver Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where ground based logging equipment removes soil cover due to the operation of feller bunchers to harvest trees, skidding of fallen trees, and construction of temporary roads or landings.. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, nonmerchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher

additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Beaver Fire area, erosion rates were modeled at an average of 4 tons per acre (range 0 to 22 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 2,054 acres or 29 percent of the fire project analysis area would temporarily not meet the soil stability indicator.

This disturbance area was calculated using the following formula which applies to all alternatives where these activities are proposed:

(100% x new landing acres) + (50% x existing landing acres) + (100% x new temp rd acres) + (100% x reopen decommissioned rd acres) + (75% x existing temp rd acres) + (5% x fuel break mechanical or hand acres) + (2% x hand thin pile burn acres) + (8% x machine pile burn fuels acres) + (15% x mastication or mechanical thin fuels acres) + (8% x machine pile burn fuels acres) + (15% x ridgetop fuels acres) + (10% x roadside fuels acres) + (2% x underburn acres) + (2% x understory thin, pile burn acres) + (10% x cable yard, plant acres) + (1% x handcut and pile burn, plant acres) + (2% x masticate acres) + (10% x masticate and subsoil, plant acres) + (1% x masticate, plant acres) + (15% x mechanical thin, pile burn, plant acres) + (20% x mechanical thin and pile, subsoil acres) + (40% x roadside ground based harvest acres) + (5% x roadside aerial harvest acres) + (35% x groundbased, hand pile, pile burn acres) + (10% x skyline harvest, hand pile, pile burn acres) + (10% x machine pile burn fuels acres) + (1% x helicopter harvest, hand pile, pile burn acres) + (15% x helicopter, machine pile, pile burn acres) = **2,054 acres affected for Alternative 2 Beaver Fire area – 5 acres currently not meeting desired condition = 2,049 acres affected by proposed project activities**

For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Mulching is generally the most effective treatment in reducing post-fire runoff and erosion (Robichaud, 2013). Compared to undisturbed areas, ground based harvest would result in approximately 20 to 30 times higher sediment yields on compacted, mulched areas, however at the watershed scale, surface runoff and sediment would be trapped, leading to localized deposition and a lower sediment yield per unit area. Rapid vegetation regrowth is expected on undisturbed areas and this would reduce the potential for this sediment to be delivered to the stream network (Wagenbrenner, 2014). Tractor harvest would therefore have a shorter-term effect on larger-scale runoff.

Project design features have been revised to require decompacting soils on new temporary roads to varying depths based on their surface texture and slope. This would improve infiltration and permeability, while avoiding greater impacts to soil stability and soil organic matter. To speed the recovery of soil cover on new temp roads, a PDF would require maintaining at least 50 percent effective soil cover.

During site preparation, manual felling of small diameter trees could also be accomplished to add soil cover on ground based harvest units. Project design feature watershed-11 would require site preparation to maintain adequate soil cover to maintain soil stability by not reducing the sum of 1, 10, and 100 hour fuels to less than less than 7 tons per acre.

With the application of these measures it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of these measures it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 956 acres, or 13 percent of the activity area may not meet the desired condition for SOM due to mechanical disturbance which could result in the displacement of SOM. This disturbance area was calculated using the following formula which applies to all alternatives where these activities are proposed:

(100% x new landing acres) + (0% x existing landing acres) + (100% x new temp rd acres) + (0% x reopen decommissioned rd acres) + (0% x existing temp rd acres) + (5% x fuel break mechanical or hand acres) + (2% x hand thin pile burn acres) + (8% x machine pile burn fuels acres) + (15% x mastication or mechanical thin fuels acres) + (8% x machine pile burn fuels acres) + (15% x ridgetop fuels acres) + (10% x roadside fuels acres) + (2% x underburn acres) + (2% x understory thin, pile burn acres) + (10% x cable yard, plant acres) + (1% x handcut and pile burn, plant acres) + (2% x masticate acres) + (10% x masticate and subsoil, plant acres) + (1% x masticate, plant acres) + (15% x mechanical thin, pile burn, plant acres) + (20% x mechanical thin and pile, subsoil acres) + (40% x roadside ground based harvest acres) + (5% x roadside aerial harvest acres) + (35% x groundbased, hand pile, pile burn acres) + (10% x

skyline harvest, hand pile, pile burn acres) + (10% x machine pile burn fuels acres) + (1% x helicopter harvest, hand pile, pile burn acres) + (15% x helicopter, machine pile, pile burn acres) = **956 acres affected for Alternative 2 Beaver Fire area – 573 acres currently not meeting desired condition = 383 acres affected by proposed project activities**

Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually due to accelerated erosion. Accelerated erosion would be expected where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter. Mechanical displacement would occur mainly due to the construction of temporary roads, landings, and skid trails, and to a lesser extent from feller bunchers operating off of skid trails. It is anticipated that SOM would not meet desired conditions on approximately 20 percent of units proposed for both ground based harvest and mechanical fuel reduction or site preparation, 15 percent of ground based harvest units, 10 percent of skyline units, and less than 1 percent of proposed helicopter units. The most severe displacement of SOM is expected to occur during temporary road construction and on landings and main skid trails. Temporary road construction would result in the highest impacts to SOM, especially on steeper side slopes which would require excavation of a cut slope. Ground based skid trails would result in displacement of SOM on skidder tracks, and where yarded trees dig into the mineral soil surface and wedge the surface to the side. This creates berms and piles along the edges of skid trails. Soil disturbance is greater on steeper slopes, and a PDF would limit ground based skidding to slopes less than 35 percent or short pitches of 100 feet on slopes less than 45 percent. Displacement caused by new skid trails and temporary road construction will be considered a long-term disturbance as no mitigations to replace displaced SOM are planned. Approximately 20 percent of the proposed ground based units have forest survey site class ratings of 4 and 5, which are lower productivity on a scale of 1 to 7. On these more sensitive soils, fewer passes of mechanical equipment could result in detrimental impacts to soil organic matter and soil productivity.

On proposed harvest units, jackpot pile burning would be expected to produce enough heat to consume SOM within the footprint of the piles.

With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 519 acres or 7 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area B: Happy Camp Complex

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter

would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. The effects to soil resources affected by the alternative are the same as described for the Beaver Fire area and would occur over the same percentages of those proposed actions. For the total Happy Camp Fire area, erosion rates were modeled at an average of 67 tons per acre (range 18 to 103 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 2,634 acres or 9 percent of the fire project analysis area would not meet the soil stability indicator. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Happy Camp Fire of 18 to 109 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

Where skidding occurs through areas with less than 50 percent soil cover, a PDF would require applying at least 50 percent soil cover on skid trails greater than 15 percent slopes. This could occur on up to 20 acres and could limit accelerated erosion.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 2,748 acres or 9 percent may not meet the desired condition for SOM due to to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.In addition the removal of soil cover could result in accelerated erosion and therefore impact SOM.

With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 1,431 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 1,729 acres or 6 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area C: Whites Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Whites Fire area, erosion rates were modeled at an average of 13 tons per acre for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 799 acres or 7 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

The effects to soil resources affected by the alternative are the same as described in the Beaver Fire area. Approximately 665 acres or 5 percent may not meet the desired condition for SOM due to to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. In addition the removal of soil cover could result in accelerated erosion and therefore impact SOM.

With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 7,752 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the soil burn severity (SBS) of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 351 acres or 3 percent of the Whites fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Alternative 3

Project Area A: Beaver Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Beaver Fire area, erosion rates were modeled at an average of 4 tons per acre (range 0 to 22 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 1,139 acres or 15 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

Approximately 143 acres or 2 percent may not meet the desired condition for surface organic matter due to insufficient retention of large woody material.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 784 acres or 10 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.

With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 378 acres or 3 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area B: Happy Camp Complex

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Happy Camp Fire area, erosion rates were modeled at an average of 67 tons per acre (range 18 to 103 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 2,590 acres or 8 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Happy Camp Fire of 18 to 109 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is

not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 2,697 acres or 9 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 1,431 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 1,705 acres or 6 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area B: Whites Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Whites Fire area, erosion rates were modeled at an average of 13 tons per acre for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 794 acres or 7 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Whites Fire of between 4 and 16 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush

vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 656 acres or 5 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 7,752 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the

SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 348 acres or 3 percent of the Whites fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Alternative 4

Project Area A: Beaver Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Beaver Fire area, erosion rates were modeled at an average of 4 tons per acre (range 0 to 22 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 1,371 acres or 18 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is

deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Beaver Fire of 2 to 6 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 947 acres or 12 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil

organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 506 acres or 7 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area B: Happy Camp Complex

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Happy Camp Fire area, erosion rates were modeled at an average of 67 tons per acre (range 18 to 103 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 2,471 acres or 8 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met.

Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Happy Camp Fire of 18 to 109 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 2,641 acres or 9 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil

organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 1,431 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 1,634 acres or 5 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area B: Whites Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Whites Fire area, erosion rates were modeled at an average of 13 tons per acre for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 800 acres or 7 percent of the

fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Whites Fire of between 4 and 16 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 669 acres or 6 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical

equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 7,752 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 335 acres or 3 percent of the Whites fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Alternative 5

Project Area A: Beaver Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Beaver Fire area, erosion rates were modeled at an average of 4 tons per acre (range 0 to 22 tons per acre) for a

single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 1,411 acres or 18 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Beaver Fire of 2 to 6 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 1,026 acres or 14 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 366 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 529 acres or 7 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area B: Happy Camp Complex

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Happy Camp Fire area, erosion rates were modeled at an average of 67 tons per acre (range 18 to 103 tons per acre) for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 1,873 acres or 6 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Happy Camp Fire of 18 to 109 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material

could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 2,171 acres or 7 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 1,431 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 1,309 acres or 4 percent of the fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Project Area B: Whites Fire

Direct Effects and Indirect Effects

Soil Stability

Soil stability and soil organic matter would be impacted on all areas occupied by new temporary roads and new landings, most of previously decommissioned roads, and portions of existing temporary roads and landings that have since stabilized. Soil stability and soil organic matter would be impacted on a percentage of units where mechanical equipment is used. Based on personal observations on the American and Rim Fire salvages, and research discussed in the soil specialist report, these percentages would be highest, approximately 40 percent, on units proposed for conventional ground based harvest followed by mechanical site preparation, and 40 percent of units proposed for ground based roadside hazard treatments. Site preparation would be designed to not reduce less than the sum of 1, 10, and 100 hour fuels to less than 7 tons per acre, and therefore maintain adequate soil cover to maintain soil stability.

Ground based harvest could be conducted using conventional or mechanized logging systems. A mechanized system could harvest material generally less than 26 inch diameter and would gently fell trees. This would minimize limb breakage and additions of soil cover, yet feller bunchers would cut and travel over smaller, non-merchantable material to incorporate it as soil cover. Mechanized systems would generally impact a larger percentage of a unit area. Conventional

logging system would yard material that has been hand felled therefore, resulting in higher additions of soil cover. Conventional harvest would likely impact a smaller percentage of unit area, yet compaction would likely be higher on skid trails.

The return of vegetation and falling dead needles have increased soil cover and decreased EHRs to moderate and rates of erosion are decreasing. On bare soil where mechanical equipment removes cover, rates of erosion could return to post fire levels. For the total Whites Fire area, erosion rates were modeled at an average of 13 tons per acre for a single 5-year runoff event. Stated accuracy is +/- 50%. Fuels treatments and site preparation using mechanical equipment would also impact soil stability on percentages of units. This would vary depending on existing soil cover, slope and operator experience. Mastication would expect to impact less than 5 percent of units, machine piling 10 percent, and mechanical thinning 15 percent. When these percentages are multiplied for all proposed treatments, an estimated 744 acres or 6 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Whites Fire of between 4 and 16 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion. This could vary greatly depending on existing soil productivity, soil erosion, and depth of A horizon.

Project design features would require subsoiling up to 60 percent of new temporary roads and landings, and would require maintaining at least 50 percent effective soil cover. If soil cover is not available, soil stability and SOM could be impacted over the long term because subsoiling can result in gully erosion if runoff is concentrated from slopes above.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

On approximately less than 5 percent of all harvested area, reductions in large woody material could lessen impacts to SOM if a wildfire occurs 10 to 15 years from now. At this time, large logs, greater than approximately 8 inch diameter, would expect to cover less than 10 percent of an area. Fuels specialist collected plot data which indicates reductions of large woody material could lessen impacts directly beneath large logs on approximately one third of the harvested area.

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 606 acres or 5 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 7,752 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the soil burn severity (SBS) of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 318 acres or 3 percent of the Whites fire area.

Cumulative Effects

Cumulative effects would be the same as described in the soil resource report.

Alternative 2 as Modified

The general direct and indirect effects described in the discussion of alternative 2 also apply to this alternative.

Project Area A: Beaver Fire

Direct Effects and Indirect Effects

Soil Stability

An estimated 1,224 acres or 17 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would

have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Beaver Fire of 2 to 6 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 820 acres or 11 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 432 acres or 6 percent of the fire area.

Cumulative Effects

Effects from grazing are as discussed under alternative 1. Adding these effects to the effects of alternative 2 will not result in measurable cumulative effects.

Project Area B: Happy Camp Complex

Direct Effects and Indirect Effects

Soil Stability

An estimated 2,634 acres or 9 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Happy Camp Fire of 18 to 109 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 2,740 acres or 9 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 366 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the soil burn severity (SBS) of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 1,720 acres or 6 percent of the fire area.

Cumulative Effects

Effects from grazing are as discussed under alternative 1. Adding these effects to the effects of alternative 2 will not result in measurable cumulative effects.

Project Area B: Whites Fire

Direct Effects and Indirect Effects

Soil Stability

An estimated 799 acres or 7 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Whites Fire of between 4 and 16 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 665 acres or 5 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter.With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 7,752 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the soil burn severity (SBS) of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 351 acres or 6 percent of the fire area.

Cumulative Effects

Effects from grazing are as discussed under alternative 1. Adding these effects to the effects of alternative 2 will not result in measurable cumulative effects.

Modified Alternative 3

The general direct and indirect effects described in the discussion of alternative 3 also apply to this alternative.

Project Area A: Beaver Fire

Direct Effects and Indirect Effects

Soil Stability

An estimated 910 acres or 16 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in short term accelerated erosion similar to those modeled following the Beaver Fire of 2 to 6 tons per acre.

Compared to alternative 3, long term accelerated erosion is much less likely to continue downslope of treatments. Half of the impacts to soil stability would occur due to ground based roadside hazard treatments, and half due to site preparation and fuels reduction activities. Ground based roadside hazard would occur on short lengths of less than 250 feet and at these shorter lengths lower rates of accelerated erosion would be expected, and further downslope transport of eroded soil is unlikely. Ground based harvest during site preparation treatments would not use mortality guidelines and therefore retention of more trees would result in more potential soil cover. By design, fuels reduction treatments would be retain soil cover to meet

LMP standards for soil cover. Therefore, its likely soil stability desired conditions would return to acceptable levels on site preparation and fuels reduction treatments in less than five years.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

The surface organic matter indicator would be met or partially met on all treatment areas. Ground based roadside hazard treatment would be expected to remove the highest amounts of surface organic matter and partially impact Surface Organic Matter desired conditions. This would occur over on areas less than 500 feet wide, and adjacent areas would contribute large woody debris to provide nutrients and habitat for soil microorganisms.

Soil Organic Matter

Approximately 906 acres or 9 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter. With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 1,431 acres that burned with low SBS. If a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 392 acres or 7 percent of the fire area. Impacts to soil structure are not expected to impact biomass productivity because soils have a moderate compaction rating and compaction deeper than approximately 6 inches is not expected. Rather, the infiltration and permeability capacity of the soil would be impacted over the short term. Widespread, long term impacts are less likely because, as described in the soil stability indicator above, soil cover is predicted to recover in the short term on fuels and site preparation treatments. Decreased accelerated erosion would promote the recovery of soil cover, vegetation regrowth, and therefore the infiltration and permeability capacity of the soil. This is less likely to occur where ground based harvest of hazard trees results in compaction in areas with insufficient cover.

Cumulative Effects

Effects from grazing are as discussed under alternative 1. Adding these effects to the effects of alternative 3 will not result in measurable cumulative effects.

Project Area B: Happy Camp Complex

Direct Effects and Indirect Effects

Soil Stability

An estimated 2,198 acres or 7 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Happy Camp Fire of 18 to 109 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 2,317 acres or 8 percent may not meet the desired condition for SOM due to

to the same proposed actions and over the same percentages as described in the Alternative 2, Beaver Fire area. Soil organic matter could be removed due to displacement from mechanical equipment or could occur gradually over time due to accelerated erosion. Accelerated erosion would be expected to decrease soil organic matter where the soil stability indicator is not met as described above. Therefore, mitigations to maintain soil stability would also maintain soil organic matter. With the application of soil stability measures described above, it is expected Forest Plan standard and guideline 3-3 would be met within the proposed activity areas.

Underburning is proposed on 1,415 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the soil burn severity (SBS) of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 1,237 acres or 5 percent of the fire area.

Cumulative Effects

Effects from grazing are as discussed under alternative 1. Adding these effects to the effects of alternative 3 will not result in measurable cumulative effects.

Project Area C: Whites Fire

Direct Effects and Indirect Effects

Soil Stability

An estimated 723 acres or 6 percent of the fire project analysis area would temporarily not meet the soil stability indicator. For any tractor harvest unit that does not meet the soil cover standards in table 4-2 of the Klamath National Forest LRMP upon completion of treatments, areas where soil cover is deficient will be mulched so that soil cover standards are met. Therefore, as described in the Alternative 2 of the Beaver Fire area section, tractor harvest would have a shorter term effect on larger-scale runoff. A loss of soil cover on this area would likely result in rates of long term accelerated erosion similar to those modeled following the Whites Fire of between 4 and 16 tons per acre. Erosion could remain elevated for 10 years until trees are planted, yet the success of conifers or brush vegetation could be delayed if soil productivity has declined due to soil erosion.

With the application of measures described above, it is expected the soil stability indicator desired conditions would be met and LMP soil cover standard 3-2 would be met within proposed activity areas.

Surface Organic Matter

Coarse woody debris will be retained to meet standards and guidelines 6-16 in the Forest Plan. Standing snags in snag retention areas and Riparian Reserves may contribute to this standard. If necessary the Forest Service will designate additional wood during implementation to be retained to meet this standard. A Project Design Feature has been added to clarify this standard as follows:

> *Maintain 5 to 20 pieces of CWD per acre with a target size of 20 inches in diameter (or larger) and about 40 cubic feet in volume when they are available. The minimum piece size to count toward these objectives is > 15 inches diameter and 10 feet long. On upper slopes and south and west aspects, ~5 pieces > 15 inches diameter and 10 feet long would be retained. On north and east aspects and on lower slopes, up to 20 pieces >15 inches diameter and 10 feet long will be retained. Individual snags, clumps of snags, existing logs on the ground and green trees within units may count towards these targets.*

With the application of measures described above, it is expected the surface organic matter indicator desired conditions would be met within proposed activity areas.

Soil Organic Matter

Approximately 449 acres or 2 percent may not meet the desired condition for SOM due to mechanical disturbance which could result in the displacement of SOM. In addition the removal of soil cover could result in accelerated erosion and therefore impact SOM.

Underburning is proposed on 5,352 acres that burned with low SBS and if a wildfire burns through the area, this treatment would provide a benefit to soil productivity by decreasing the SBS of a future fire. Because this is an unpredictable event, this potential benefit has not been factored into area meeting desired conditions.

Soil Structure

It is expected soil structure would not meet desired conditions on approximately 335 acres or 3 percent of the fire area.

Cumulative Effects

Effects from grazing are as discussed under alternative 1. Adding these effects to the effects of alternative 3 will not result in measurable cumulative effects.

Table 8: Summary acres not meeting desired condition for each soil resources indicator for the Beaver Fire Area. The acres not meeting desired condition for alternatives 2, 3, 4, 5, mod alternative 2 and mod alternative 3 include the acres not meeting for alternative 1 (affected environment).

Indicator	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Mod Alt. 2	Mod Alt. 3
Soil Stability	5	2,054	1,139	1,371	1,411	1,224	910
Surface Organic Matter	0	674	143	619	673	413	0
Soil Organic Matter	573	956	784	947	1,026	820	906
Soil Structure	269	519	378	506	529	432	392

Table 9: Summary acres not meeting desired condition for each soil resources indicator for the Happy Camp Complex Area. The acres not meeting desired condition for alternatives 2, 3, 4, 5, mod alternative 2 and mod alternative 3 include the acres not meeting for alternative 1 (affected environment).

Indicator	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Mod Alt. 2	Mod Alt. 3
Soil Stability	633	2,634	2,590	2,471	1,873	2,634	2,198
Surface Organic Matter	0	534	438	481	182	476	299
Soil Organic Matter	642	2,748	2,697	2,641	2,171	2,740	2,317
Soil Structure	383	1,729	1,705	1,634	1,309	1,720	1,237

Table 10: Summary acres not meeting desired condition for each soil resources indicator for the Whites Fire Area. The acres not meeting desired condition for alternatives 2, 3, 4, 5, mod alternative 2 and mod alternative 3 include the acres not meeting for alternative 1 (affected environment).

Indicator	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Mod Alt. 2	Mod Alt. 3
Soil Stability	280	799	794	800	744	799	723
Surface Organic Matter	0	33	12	12	12	12	12
Soil Organic Matter	280	665	656	669	606	665	449
Soil Structure	50	351	348	355	318	351	335