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Grasshopper Restoration Project

Soil Resources Report

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for:
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Mt. Hood National Forest

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1.0 Introduction

This is the specialist report that addresses effects to soil resources that will be incorporated into the Grasshopper Restoration Environmental Analysis (EA). In this report are described the existing conditions, and an analysis of the environmental consequences to soil resources that could be expected as a result of No Action, or by implementing either of the Action Alternatives. The EA is incorporated by reference and provides a description of proposed activities in Chapter 2. Protecting and conserving soil resources has long been a designated integral objective of managing natural resources on National Forest System Lands. Direction has been in place for decades in Forest Service Manual 2550 that, depending on the region, translates into specific standards and guidelines that are defined in the Land and Resource Management Plans (LRMP) of individual National Forests.

These objectives are generally aimed at maintaining or enhancing long-term site productivity so that the inherent capability and function of soil resources to support forest or range plant communities and provide for ecosystem services (ex. forest products, wildlife habitat, source water) is enduring. Evaluating the potential effects to soil quality and productivity from activities on Forest Service lands is essential to achieving those objectives.

It is helpful to understand several fundamental terms common to the consideration of land use on forest soils: 1) soil quality, and 2) soil productivity. They often are used interchangeably.

> Soil Quality: The capacity of a specific kind of soil to function, within natural or managed ecosystems, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation.
>
> Soil Productivity: The inherent capacity of the soil resource to sustain appropriate site-specific biological resource management objectives, which includes the growth of specified plants, plant communities, or a sequence of plant communities to support multiple land uses. (Forest Service Manual 2550.5).

Soil quality and productivity are dynamic. Soil properties can change depending on how it is managed. Management choices can affect soil organic matter, soil structure, soil depth, and water and nutrient holding capacity. Soils respond differently to management depending on the inherent properties of the soil and the surrounding landscape.

2.0 Analysis Framework

The emphasis of this analysis has been based upon potential effects to soil resources that could be anticipated as a result of ground disturbing activities. The analysis also evaluates the project's consistency with agency plans and directives aimed at conserving or enhancing long-term forest productivity and managing soil quality in a sustainable manner for desired future conditions.

Actions addressed here include those associated with proposed timber harvest activities, silvicultural and forest health treatments, prescribed fire, habitat enhancement, road use and management, and recreational uses.

Interpretations and descriptions contained in this specialist report rely heavily on local information derived from the Mt Hood National Forest's Soil Resource Inventory (SRI, Howes, 1979) and digital spatial data in the Forest Service's corporate Geographic Information System (GIS). These information sources were used along with topographic maps, aerial photographs, silvicultural reports, field-based reconnaissance and sampling, various related project reports, and agency directives to characterize local conditions and support analysis used to predict environmental consequences of the Alternatives.

2.1 Resource Indicators and Measures

The analysis of effects to soil resources in this EA has been focused on the project areas and the individual units proposed for treatment. Select standards and guidelines (S&Gs) from the Mt Hood National Forest LRMP (USDA 1990) serve as the basis for analyzing the effects of each of the alternatives (Table S1).

Table S1. Key indicators and measures to be used for assessing effects to soil resources

Resource Indicator	Measure	LRMP Forestwide Standards and Guidelines
Extent of Detrimental Soil Conditions	Percent Detrimental Condition	FW-022, 023
Soil Erosion Hazard Class	Percent Effective Ground Cover	FW-025
Amount of Surface Organic Matter	Tons per Acre	FW-031 to 037

Extent of Detrimental Soil Condition: LRMP standards and guidelines FW-022 and FW-023 state that the extent of detrimental soil conditions should not exceed 15 percent in an activity area (i.e., treatment unit) following project completion to maintain and conserve site productivity. Detrimental soil conditions include heavy compaction, displacement, puddling, accelerated erosion, excess loss of organic material, and severely burned soils (for definitions see Forest Service Manual, section 2520.98-1, 1998).

Not all ground disturbance is considered to be detrimental. Impacts from ground disturbance where the extent and magnitude are severe enough to diminish soil quality and soil productivity to the degree that soil processes are not fully functional over the long-term are considered to be detrimental.

Soil Erosion Hazard Class: LRMP standards and guidelines FW-025 and FW-026 prescribe that, depending upon the erosion hazard rating for a particular soil type, an effective percentage of

ground cover should be established after ground disturbing activities to prevent and minimize accelerated erosion. Accelerated erosion has the potential to degrade on-site productivity due to soil loss, as well as affect water quality off-site from runoff and sedimentation. Effective groundcover is key to reducing or eliminating the potential for accelerated erosion.

Amount of Surface Organic matter: LRMP standards and guidelines FW-031 and FW-036 stipulate the retention of sufficient quantities of post-project dead and downed woody material so that the contribution of organic matter to soil productivity is maintained. Expressed quantities are considered to be a proportion of the total potential biomass that a representative ecotype could inherently produce. Retention of surface organic matter is a means for maintaining the function of soil biological systems, and mutually beneficial forest nutrient and carbon cycling.

2.2 Methodology

Analysis of the anticipated effects to soil resources was conducted using a methodology that is essentially qualitative, but with a quantitative component. The quantitative extent of detrimental soil conditions was estimated using sampling data, field reconnaissance, GIS analysis, and aerial photographic interpretation; which also functioned as the basis for deriving and validating assumptions and inferences. Effects to soil resources were determined qualitatively based upon select physical and biological properties fundamental to the sensitivity and resilience of soils to certain types of disturbances. Factoring both the quantitative extent of detrimental soil conditions with the qualitative assessment of response to disturbance served as the method for predicting the potential effects to soil quality and productivity.

Due to the variability of past ground disturbance in the project area, the quantitative extent of detrimental soil conditions was characterized for this analysis by categorizing them into classes. Soil condition classes represent a range of the aerial extent of detrimental soil conditions. Expressed as a percentage of an individual treatment or activity unit, three soil condition classes were defined, they are:

- Soil Condition Class 1: less than 5 percent detrimental soil conditions
- Soil Condition Class 2: 5 to 10 percent detrimental soil conditions
- Soil Condition Class 3: greater than 10 percent detrimental soil conditions

These three stratifications were based upon the sensitivity of data to be able to estimate the gradations of detrimental soil conditions and their extent. They serve as a means for assessing the relative risk of a particular treatment or activity to increase the extent of detrimental soil conditions to a level that compromises soil quality and long-term site productivity. Units estimated to have a high proportion of their acreage in the uppermost condition class were identified as having the greatest potential for incurring a level of detrimental soil impacts that put at risk the productivity standards set forth in the LRMP.

There is an important prospect regarding soil condition classes to be mindful of. Though they convey an estimate of the range of detrimental soil conditions that extend across an activity area, they also passively imply the extent of soil conditions that are not detrimental. If for example an activity area is designated to be in soil condition class 2, meaning detrimental soil conditions comprise less than 10 percent of its area, then the converse is that soil conditions across at least 90 percent of that unit's area are in good functioning condition. This reflects the variability of effects that is typical after ground disturbance, whereby detrimental conditions are associated with the intensity of the impact. For ground-based operations detrimental soil impacts are inextricably tied to the routes and repetitiveness of travel by heavy equipment such as the network of roads, landings, and skid trails needed for logging.

Erosion hazard rating and organic matter indicators have also been assessed qualitatively using a cause-and-effect precept. Spatial extent of potential effects will have been estimated using GIS to relate soil inventory data with stand structure information and proposed treatments. Characteristics of affected soil types have been evaluated to interpret expected response of proposed treatments given forest structural conditions. Potential outcomes take into account the capability, limitations, sensitivity, and resilience of individual soil types.

Cumulative effects were analyzed qualitatively. They were assessed by evaluating existing detrimental soil conditions in relation to where proposed activities would occur. Cumulatively the past, present, and reasonably foreseeable actions in the project area where ground-disturbing activities will have overlapped one another constitute the basis and scale for analysis. Ameliorative factors such as avoidance, mitigation (ex., subsoiling, fertilization, mulching, etc.), and recovery have been factored in. Simplistically, the cumulative assessment can be represented as a qualitative sequence to evaluate the probability and magnitude of overlapping effects both spatially and temporally.

> (existing + predicted + future impacts) – (avoidance + minimization + mitigation + natural recovery) = potential cumulative effects

The analysis of effects to soil resources considered the following assumptions:

- Prescribed Project Design Criteria (PDC) would be effective at avoiding or minimizing potential detrimental effects to soil resources. They would be requisite for, and applied during project implementation. For example, ground-based skidding on steep slopes would be avoided. Skidding would be limited to slopes 40 percent or less. For a complete list of PDC, see Appendix A of the EA.
- Existing landings, non-system roads, and skid trails would be reused where feasible.
- Existing non-system roads or landings not used during the project would remain in a detrimental condition.
- New primary skid trails would average 10 feet in width.
- New temporary roads would average 12 feet in width.
- Skidding and yarding patterns would be arranged to minimize their extent within a

treatment unit to only what is necessary.

- Detrimental soil impacts have long-lasting effects to soil productivity.
- Prescribed fire within project boundary will be dominated by low burn intensity with the intention of leaving 50% of effective ground cover, on average.

3.0 Existing Conditions

3.1 Soil Characteristics and Distribution

The Soil Resource Inventory (SRI) of the Mt Hood National Forest (Forest) identifies the distribution and character of the many soil types across the landscape (USDA 1979). It provides basic soil and landform information useful for land management planning. In it are descriptions of soil types that occur on the Forest, maps of their spatial extent, some of their chemical and physical properties, and interpretations of their capabilities and limitations. It also contains some general information about climate, geology, and vegetation. The SRI has been used to determine the soil types in the project area and serves as the foundation supporting the analysis of effects.

The dominant parent material is derived from glacial deposits mixed with volcanic ash. The underlying bedrock is andesitic and dominates the coarse fragments in the soil and on the landscape. The landscape is defined by a gently sloping erosional platform with steeper slopes located along the drainages. A soil map is available in the project record, which shows the overlays of soil type and proposed treatment areas.

Surface soil textures vary from fine sandy loams to heavy silt loams. Subsurface layers are dominated by large amounts of rock and are mostly moderately deep to deep but shallow soils can be commonly found in areas around talus and exposed bedrock. Occasionally, there is either a compacted glacial till deposit or bedrock at shallow depth, but for the most part, soils are well drained. The rockiness found across the area gives it an inherent resistance to the compaction from equipment, which also facilitates the resilience of the areas ability to recover from impacts. The soils with the least amount of rock occur in non-glacial soils which account for a little less than 10% of the planning area. The concept of soil resistance and resiliency is presented in literature (Seybold, et.al., 1999), and at a minimum, provides a useful framework for comparing one soil type to another. Vegetation patterns are driven by the presence of surface and subsurface water, precipitation, elevation changes, and former disturbance including past forest and grazing management.

A summary of soil mapping units and their associated management interpretations is located in Table S2 below. Key observations from the table include:

- 98% of the area proposed for treatment is underlain by soils with a moderate to low

compaction hazard[1].

- Erosion potential for soils with slopes less than 30% is moderate to slight for undisturbed, bare soil
- Erosion potential for bare soils on slopes greater than 30% is rated moderate to severe.
- Most ground-based activity would occur in areas on less than 30% slope

Table S2. Summary of soil types in the analysis area and associated management interpretations from Mt. Hood Soil Resource Inventory.
*All percentages are approximate.

SRI Unit	Compaction Hazard	Surface Erosion Potential	% Slope	% of Planning Area*
3,4 (alluvial, high water table)	high	very slight	0-10	0.69%
6,7 (talus, bedrock)	low	very slight	30+	0.35%
153, 156	low-mod	slight-mod	0-30	5.96%
155, 157,	low-mod	mod	30-60	1.73%
158, 159	mod-high	mod	30-60	2.09%
350, 351	low-mod	mod	0-30	10.69%
352, 353, 356	mod	slight	0-30	62.88%
354, 355, 357	low-mod	mod-severe	30-60	15.61%

3.1.1 - Resource Indicator 1: Extent of Detrimental Soil Conditions

The extent of detrimental soil conditions (DSC) is low, with nearly 90 percent of units falling into soil condition class 1 (less than 5% DSC) and none of the units falling into soil condition class 3 (10% or greater DSC). Across the project area, approximately two thirds of the units being proposed for treatment would occur in forested stands that have been previously managed. The remaining percentage would occur in stands that have not been actively managed in the recent past (e.g. unmanaged stands). Some of these unmanaged stands may have been selectively harvested in the late 1800s or early 1900s but records of such activities do not exist at the site-specific scale. Of the previously managed acres, about half has been harvested in the last 25 years. The last third of the units (half of the managed stands) had been harvested between 30 and 60 years ago. Overall, the extent of detrimental soil conditions is low and none of the units are classified as having soil condition class 3 (greater than 10% DSC). However, a select subset of units (see PDC) has been identified for additional consideration due to the current extent of ground disturbance.

[1] This interpretation indicates a soils inherent ability to be compressed by ground yarding equipment to a point where plant growth is either slowed considerably or stopped. Mt. Hood SRI

Detrimental soil impacts that linger from past logging have been detected in the form of old spur roads and primary skid trails, and landings. Heavy compaction or displacement can be observed where these features are located. Nearly all were detected in previously managed stands. Table S3 summarizes the estimated extent of these residual soil impacts across the areas proposed for treatment.

Table S3: Percentage of Acreage Proposed for Treatment*

Soil Condition Class	**% Units**
Soil Condition Class 1 (0-5% detrimental soil conditions)	87%
Soil Condition Class 2 (5-10% detrimental soil conditions)	13%
Soil Condition Class 3 (>10% detrimental soil conditions)	0%

Percentages are approximate.

Given the disturbance history, and that none of the stands proposed for treatments were determined to exhibit Soil Condition Class 3, it suggests that there has been a high degree of natural recovery that has occurred since prior ground disturbance. These soils display a measure of resiliency, and an intrinsic ability to recover from detrimental soil impacts.

Along with natural recovery in the proposed treatment units, there have been restorative activities that benefited soil conditions and enhanced soil quality. Tree planting was mandatory in units where regeneration timber harvest occurred and reforestation occurred in the Grasshopper Burn area to hasten post-wildfire recovery. Other beneficial post-harvest activities included erosion control seeding of bare surfaces to prevent soil loss, and restoration projects such as road decommissioning that have offset some of the detrimental conditions that remain.

Due to their productive capability and resilience, soils in the treatment units continue to retain their function despite previous disturbance from management, serving as a growing medium, storing and cycling nutrients and water, producing biomass, and supporting or regenerating a contiguous forest cover. Currently, conditions in all of the units proposed for treatments are consistent with the LRMP forest wide S&Gs FW-022 and 023 for soil productivity.

3.1.2 - Resource Indicator 2: Soil Erosion Hazard Class

As indicated in Table S4, nearly all of the acreage proposed for treatment is categorized to be in the slight to moderate soil erosion hazard class as defined by the LRMP (1990). The soils in the project area are similar in parent material and age, therefore the soil properties overlap considerably. Excluding ground cover, variability in slope is the most determining factor in soil erosion hazard class. The majority of soils have a slight to moderate soil erosion hazard and areas with mod-severe class are located on the highest slopes (>40%).

Table S4: Soil Erosion Hazard Class – Percent of Total Acreage Proposed for Treatment*

Treatment Area	Slight to Moderate	Mod-Severe	Severe to Very Severe	Not Rated (rock outcrops, etc)
% Project Area	84%	15%	0%	1%

Percentages are approximate.

Erosion rates are not currently accelerated to a noteworthy degree as a result of past activity in proposed treatment units. Natural re-establishment of grasses, forbs, brush, tree regeneration, and reforestation has acted to effectively provide ground cover. Within units proposed for treatment in the Grasshopper project area, the extent of ground cover is considered sufficient to facilitate infiltration during precipitation events and prevent undue erosive forces from displacing soils. While there may be isolated evidence of accelerated erosion resulting from residual detrimental soil impacts, these areas occur on a very minor portion of total project area. Accelerated erosion that was observable can be attributed primarily to the existing road system and heavily used dispersed recreation sites. Conditions in all of the units proposed for treatments are considered to be consistent with the LRMP Forestwide S&G FW-025 for effective ground cover and soil productivity. Based on observations and interpretations of soil erosion hazard in the project area, the project design criteria will be sufficient to keep conditions within thin the LRMP Forestwide S&G.

3.1.3 - Resource Indicator 3: Amount of Surface Organic Matter

Organic matter is abundant across most of the Grasshopper project area. There is generally a contiguous organic layer of litter and duff that covers the forest floor of the proposed treatment units. The relatively dense forest cover in much of the project area has been generating litter-fall for the forest floor annually for decades, contributing fine needles and leaves, small branches, and larger limbs and stems from dead and decaying trees and brush. Although the total amount of surface organic matter is considered to be sufficient, the diversity of the types and sizes varies from unit to unit and, in some cases, the quality and amounts of downed coarse woody debris (CWD) is below Forest Plan standards (e.g. FW-033). The majority of sapling plantations are still developing and frequently lack suggested quantities of larger size classes of CWD, whereas the majority of unmanaged stands meet or exceed Forest Plan standards for the quality and abundance of CWD. Across all stands, the recruitment potential for CWD is high and nutrient cycling is considered to be properly functioning.

3.2 - Environmental Consequences

The scope of this analysis is to evaluate impacts to soil resources that could be expected as a result of either implementing or not implementing forest management activities being proposed in the Grasshopper Restoration project area. Activities analyzed include those associated with mechanized commercial treatments of the forest overstory and understory, as well as hand treatments in young sapling plantations. Findings predict the direct, indirect, and cumulative effects based upon scientific analysis, relevant research, professional judgment, and

well-established cause-and-effect relationships between natural resource management and soil response on the Mt Hood National Forest.

Analysis of the direct and indirect effects was conducted at the treatment unit scale. Units are considered to be individual stands of trees or larger delineations of multiple stands where similar treatments are proposed. Units are the areas where ground impacting activities would occur. Cumulative effects were also analyzed at the unit scale, and considered at the project area scale, particularly in relation to soil function to discern potential effects to ecosystem services across the landscape.

3.2.1 – Effects of No Action

Under the No Action alternative, ground-disturbing activities related to the proposed treatments would not occur. Measurable increases in the extent of detrimental soil conditions as a direct result of mechanical ground-based operations would not happen. Soil quality would not be expected to be diminished further on disturbed sites, but would remain compromised where existing detrimental soil conditions prevail such as old spur roads, previously used landings, and former primary skid routes. Areas in and around dispersed recreation sites would be expected to neither improve nor deteriorate with the expectation that those areas didn't expand.

Soil quality would remain degraded where detrimental soil conditions persist, and long-term site productivity would be diminished on those sites. A reduced rate of tree growth is an indirect consequence.

Other than the extent of existing detrimental soil conditions, soil quality across the majority of the project area would remain in good condition despite the level of prior management. Natural recovery from past impacts would slowly continue to occur unabated.

The opportunity to optimize soil quality by treating young sapling plantations would not occur. Without thinning, growth rates and soil productivity in the sapling plantations would decline as competition for nutrients, light, and growing space increased. Vertical and horizontal differentiation of trees would remain sluggish, and stand diversity would be delayed until competition and/or disturbance occurred naturally. Persistence of these conditions would delay the recruitment potential for larger size classes of CWD.

The ability to enhance growth and capitalize upon inherent soil productivity through active timber management would not be captured. Soil productivity would continue to be heavily utilized to support the dense quantity of stems, and resilience under-utilized for enhanced structure development. Soil function would be committed to supporting a stagnant stand condition at risk of loss or reversion to poor forest health, rather than the hastened development of a young stand into a vigorous mid-aged structural stage.

Similarly, inherent soil productivity in the dense homogeneous outer riparian zones proposed for treatment would also remain committed to an overstocked condition. The ability to enhance

riparian diversity and health would not be captured in the near-term. Soil function would not be committed to hastening large-tree development and promoting old growth characteristics. Instead, soil function would be committed to supporting dense stand conditions where the overstocked understory would be in competition with overstory development.

There would be no new temporary roads created, and no closed roads temporarily re-opened. The extent of the disturbance footprint would not increase for the purposes of forest management. Rehabilitation of temporary roads would not be necessary.

Road maintenance and repair would continue at the current level and improvements to primary access routes or problem sites would only be pursued on a site-by-site basis as funding became available. Certain segments of secondary roads with drainage control problems could remain unrepaired for years. Accelerated erosion would continue during periodic runoff events from certain road segments.

Except for the sites where detrimental conditions remain, soils across the majority of the project area would continue functioning fully to support and maintain long-term site productivity. Detrimentally disturbed sites or those that support densely stocked stands where growth has slowed will remain in a status of either slow recovery or stasis. Other than those sites however, the inherent productivity and resilience of the soils will help to maintain their functional capacity to serve as a growing medium, storing and cycling nutrients and water, producing biomass, and supporting or regenerating a contiguous forest cover of various plant communities.

3.2.2 - Direct and Indirect Effects of Action Alternatives

Alternative 1 (the Proposed Action) and Alternative 2 (the Shelterwood Alternative) would generally have the same potential effects to soil resources. Therefore, unless otherwise noted, the effects analysis presented below is intended to apply to both Action Alternatives.

3.2.3 Resource Indicator 1: Extent of Detrimental Soil Conditions

The direct effects of proposed activities on detrimental soil conditions relate to mechanical harvesting and yarding in the logging systems used. Temporary roads that are created will increase compaction and have the potential to displace the surface horizon that is vital for soil health and productivity. Similarly, use of heavy equipment off-road would create some negative impacts to soils as wheels and tracks exert compressive and shear forces on the soil surface. Ground-based equipment is proposed to be used in units that have less than 40% slope, which characterizes approximately 90% of the units proposed for treatment.). Ground disturbing impacts are also possible in units with greater than 40% where cable logging systems are implemented where yarding occurs. Additionally, post-treatment restorative actions, such as scarification of landings and temporary roads, would help ensure a relatively rapid recovery of productive soil characteristics.

Treatment units where thinning is done by hand ground effects will be nil. Units where mechanical fuels treatments and variable density thinning are proposed, the heaviest ground effects would be concentrated to the skidding network or where repetitive passes by machinery is expected. Mechanical travel across most of the unit area would be subject to single passes where impacts would be minimal and short term.

Long term impacts due to displacement of the surface mineral horizons could be expected where primary skid trails and landings are located. The rocky soils in the project are considered to be resistant to heavy compaction and can recover from minimal disturbance. Displacement of topsoil will likely have longer term effects and not recover rapidly. Displacement occurs most notably when soil moisture is at its lowest. Project design criteria that limit the extent and timing of ground-based mechanical operations are intended to minimize soil displacement and heavy compaction. Currently, conditions in all of the units proposed for treatments are consistent with the LRMP forest wide S&Gs FW-022 and 023 for soil productivity. Based on the ground-based observation as well as interpretation from remote sensing data and previous mapping within the project area, the project design criteria will be adequate to maintain soil conditions and will not exceed LRMP Forestwide S&G.

3.2.4 Resource Indicator 2: Soil Erosion Hazard Class

Reduction of ground cover can affect existing soil erosion hazard class. Logging systems have the potential to reduce ground cover. PDC are prescribed to minimize losses of groundcover.
Soil Erosion Hazard is linked to soil properties, surface cover and geomorphic position. As noted in section 3.1, soil types across the project area are similar and have comparable properties. The variability within soil type in the project is from geomorphic position as related to slope and depth to bedrock.

The risk to soil erosion will most likely be highest in areas where effective ground cover is reduced to a notable degree. This would expose the soil surface to erosion from rain drop impacts and in areas of higher slope could result in sedimentation. Soil erosion could be expected where impacts to the soil surface would be compacted and displaced in the skidding network. Compaction obliterates soil structure and reduces infiltration and consequently increases energy of runoff. The increased runoff increases the likelihood of erosion and sedimentation.

Project design criteria specify ground cover requirements that will protect the soil resource by minimizing the loss of ground cover. Currently, conditions in all of the units proposed for treatments, are considered to be consistent with the LRMP Forestwide S&G FW-025 for effective ground cover and soil productivity. PDCs will adequately maintain current conditions as to not exceed the LRMP Forestwide S&G to maintain effective ground cover and minimize displaced and compacted soil..

3.2.5 Resource Indicator 3: Amount of Surface Organic Matter

In units where ground-based equipment would operate, surface organic material would be disturbed as a result of heavy equipment. Surface organic material would be completely removed and denuded from primary skid trails, landings, and temporary roads. In units where timber harvest occurs with cable yarding systems, it would be expected that yarding corridors would be similarly disturbed. The extent of these features would be controlled and limited, so that the majority of the ground would be less disturbed and still covered by a nearly contiguous layer of litter and duff.

Table S5

Treatment/Stand Type	**Target Tons/Acre**
Dry Mixed Conifer	10-15
Wet Mixed Conifer	20-25
Shelterwood*	15-20

*treatment proposed in alternative 2

Tree removal resulting from timber harvest would decrease total on-site biomass for a short time. In units where fuels reduction treatments occur the immediate influx of fine organic inputs would be further increased in the long term. Additionally, standing dead (e.g. snags) and existing larger diameter downed CWD would be retained on-site wherever feasible (see PDC). Densely stocked patches of intact forest called, “skips” would be also left across about 10 percent of variably-thinned treatment units and would continue to provide for future recruitment of CWD.

Once the canopy is opened up, new growth of understory vegetation would contribute an ongoing supply of organic matter over the long-term. The residual forest cover left on-site would continue to generate litter-fall for the forest floor, contributing fine needles, small branches, and larger limbs and stems. In stands with rocky, shallow soils, where treatment would include heavy thinning or shelterwood, it could be expected that windthrow would contribute additional supplies of CWD in the near-term. Given these conditions, the total amount of surface organic matter to remain after treatment would be sufficient for supporting the function of soil biota that facilitate site productivity.

The distribution of the types and sizes of surface organics would be re-apportioned, particularly from the canopy to the forest floor. This re-apportioning of organics would be most pronounced in units receiving heavy thinning or shelterwood treatment. While fine organic material may be abundant post treatment, approximately half of these stands are currently estimated to be below Forest Plan standards (FW-033) for abundance of larger diameter CWD and those conditions would continue to persist in the short-term. Similarly, in the short-term, the amount and distribution of downed CWD in thinned plantation stands would remain low.

On average, across the project area, forest response to thinning would correlate to an increase of growth and the production and storage of future available CWD in larger diameter classes. Growth of the residual forest and individual trees would temporarily exceed mortality, continually generating biomass. In the long-term, growth would become more balanced with mortality, and the eventual source of CWD from the residual stand more consistent. The amount of biomass on the ground and stored in the standing live trees would remain abundant, and serve as a long-lasting source of surface organic matter in the treatment units. Organic substrate supporting the proliferation and functionality of soil biota would likewise continue, perpetuating long-term site productivity. Currently, conditions in all of the units proposed for treatments, are considered to be consistent with the LRMP Forestwide S&G FW-031, FW-037. The PDCs proposed will adequately maintain current conditions consistent with the LRMP Forestwide S&Gs by maintaining surface organic matter across the project area.

3.2.3 - Cumulative Effects

Cumulative effects to soil resources were analyzed qualitatively by evaluating the past, present, and reasonably foreseeable actions in the project area where ground-disturbing activities would overlap one another in time and space. The interdisciplinary team listed projects and activities that should be considered in the cumulative effects analysis. This information is included in the project record. This analysis considered those activities that could contribute to cumulative effects on soils. Effects were assessed at two scales, the unit and the project area. Focally, and at the unit scale these would be sites where multiple activities would, or would have affected the same piece of ground. Because detrimental soil impacts are considered to be long-lasting, multi-decadal timescales are the temporal context of cumulative effects to soil resources.

Disturbance to soil is confined to direct impacts at the point of contact with the soil. That point of contact can permeate into the soil profile depending on the kind and intensity of the disturbance. Current measurable soil disturbance in the project area has been mostly caused by human disturbance and, to a lesser degree, fire. Within the project area the soil disturbance from past fire is minimal because large-scale high intensity fire has not occurred for more than 50 years.

Past and ongoing human activity has the most measurable impact on the soil within the project area. In the past livestock grazing occurred in the area. Grazing does not occur currently but may in the future. Ground effects from previous logging operations are still evident in the form of compaction from decommissioned roads and skid trails. On a smaller scale, past and ongoing human activities in the project area include firewood collection, OHV use and other recreation. These activities are low impact but there could be ongoing motor vehicle traffic on non-system roads and dispersed camping areas that may have effects by maintaining disturbance without allowing areas to recover. This is to a minor extent and has no measurable effect. The Forest is also constantly seeking out perspective areas for restoration. It is possible that restoration could occur in the project area within the foreseeable future.

Most of the proposed treatments would enter stands that have been treated previously. For this reason, the potential for cumulatively accruing detrimental soil conditions is likely. Treatment units that exhibit Soil Condition Class 2 would be at the greatest risk, where containment of detrimental soil effects could be a challenge to limit. Coordination between Forest contract administrators, resource specialists, and operators to implement BMPs/PDC would mitigate the extent of detrimental soil impacts. The current analysis shows cumulative impacts would not lead to exceeding the LRMP Forestwide S&G for effective ground cover and soil productivity.

3.3 - Consistency with Management Direction

The Proposed Action as planned would be considered consistent with the LRMP Standards and Guidelines (S&Gs) for soil productivity (FW-022 to FW-037). BMPs/PDCs would be the principal tools and measures to be employed during implementation to achieve consistency.

Table S6. Key indicators and measures used for assessing soil resource protection

LRMP Forestwide Standards and Guidelines	Measure	Principle Means of Consistency
FW-022, 023	Percent Detrimental Condition	Contract administration: • containment of the extent of landings, primary skid trails, and temporary roads • minimizing repetitive travel off primary skid trails • Post-harvest rehab. of primary skid trails and landings • road decommissioning/closures
FW-025	Percent Effective Ground Cover	Contract administration: • containment of the extent of landings, primary skid trails, and temporary roads Natural recovery • revegetation, continuing litter fall
FW-031 to 037	Tons per Acre	Contract administration: • retention of residual on-site biomass • overstory green-tree retention Natural recovery • renewable supply in overstory • growth response • understory re-growth • continuing litter fall • eventual mortality in larger diameter classes

Proposed treatments are also consistent with the S&Gs of the Northwest Forest Plan (NWFP). Consistency would also be achieved by employing the BMPs/PDCs.

Table S7. Northwest Forest Plan Consistency

NWFP Standards and Guidelines	Measure	Principle Means of Consistency
Page C-40	Amounts of CWD	Contract administration: • retention of residual on-site biomass • overstory green-tree retention Natural recovery • renewable supply in overstory • growth response • understory re-growth • continuing litter fall • eventual mortality in larger diameter classes
Page C-44	Minimize soil and litter disturbance	Contract administration: • containment of the extent of landings, primary skid trails, and temporary roads • minimizing repetitive travel off primary skid trails • Post-harvest rehab. of primary skid trails and landings

5.0 - References Cited

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