SOIL SPECIALIST REPORT
Bald Fire Salvage and Restoration Project

Lassen National Forest
Hat Creek Ranger District
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The Bald Fire Salvage and Restoration Project (Bald Project) would comply with the Lassen National Forest Resource Management Plan standards for long-term soil productivity. The proposed salvage and fuel treatments in each alternative are not expected to adversely affect soil resources because of design criteria that will be implemented as part of each management alternative. These design criteria will help to ensure that resource safeguards will be in place that would prevent adverse effects on the soil resource from occurring.

INTRODUCTION

This report provides an analysis of the effects of the Bald Project on soil quality in the project area.

The report describes the soils in the project area, provides an assessment of current soil conditions, and analyzes the potential effects that treatments under the proposed action might have on the soil resource.

The report includes:

- applicable standards and guidelines that were used to evaluate soil condition and potential impacts of proposed treatments;
- a description of the methods used to assess the effects of the project on soils;
- a description of the affected environment, including soils of the project area, their mapped distribution, and assessment of their current condition as affected by past management activities and wildfire; and
- an assessment of the direct, indirect, and cumulative effects of the proposed action on the soil resource.

Standards and Guidelines

Applicable standards and guidelines for soil quality are provided by the Lassen National Forest Land and Resource Management Plan (1993) and the Sierra Nevada Forest Plan Amendment (2004). See Appendix A for a complete list of standards and guidelines for soil productivity.

METHODS

SOIL RESOURCE INFORMATION

General soils information for the project area was obtained from Soil Survey Staff, the Natural Resources Conservation Service, the United States Department of Agriculture, and the Soil Survey Geographic (SSURGO) Database for the Lassen National Forest (SSURGO, 2015). This soil information includes soil maps, map unit descriptions, information on soil properties, hydrologic soil groups, and soil interpretations.

SOIL EROSION HAZARD RATING

The California Soil Survey Committee Erosion Hazard Rating (EHR) System (CSSC, 2001) was used to rate the risk of soil erosion for all soils in the project area. This system uses various physical soil properties along with climate and site-specific conditions to rate soils for hazard of

sheet and rill erosion. The rating method was modified to include the hydrological effects of soil burn severity.

SOIL COMPACTION RISK RATING

The Region 5 Detrimental Compaction Risk Rating Guide (Roath, 2006) was used to rate the risk of compaction for soils in the project area. This rating guide uses soil texture and rock fragment content, as determined in the field, to determine the inherent physical risk of compaction for a given soil.

POST-FIRE BAER ASSESSMENT

Wildfire effects on the soils were assessed by the Bald Fire Burned Area Emergency Response (BAER) Team. The BAER assessment area included all of the Bald Project area. Effects interpretation relies upon assessment of soil burn severity and rating of erosion hazard. It is important to note that BAER assessment is a *rapid* assessment process; due to the rapid nature, it is not intended or expected to be entirely comprehensive and accurate. It is however a quality assessment of overall post-fire conditions and fire effects on the soils, and mapping products are geographically accurate in most of the area.

Soil Burn Severity (SBS) is a summary rating of soil condition post-fire, for the purpose of rapidly stratifying the burn area, identifying source areas of greater potential for runoff and erosion, and assisting other resource specialists in prioritizing where to spend limited field time. SBS is an integrative indicator of aboveground *and* belowground fire effects, not merely a vegetative mortality rating. SBS is also used to identify potential treatment areas to prevent potential 'emergencies' as defined by the BAER process.

SBS was mapped and field verified; methodology followed Parsons (2010). The following are simplified descriptions of the ratings. Low SBS has a mosaic underburn with good overstory survival, so acceptable canopy cover remains for the soil; soils have little heat penetration and should continue to function normally; soil cover remains largely intact. Moderate SBS has high understory consumption along with high to complete overstory mortality; the 'brown crowns' are not all consumed, however, dead foliage is present in portions of moderate SBS areas to provide soil cover in the form of needlecast in the short term; up to 80 percent of litter and duff may have been consumed; soils have moderate heat penetration but should recover adequately after a modest potential for first-year erosion. High SBS has complete understory consumption and overstory mortality, with crown foliage consumed and no potential soil cover; soils have hotter and deeper heat penetration, with partial destruction of soil organic matter and surface structure; infiltration is affected and erosion potential elevated for four to five years post-fire.

FIELD OBSERVATIONS

The Lassen National Forest (LNF) soil scientist and two other soil scientists made field observations as members of the Eiler-Day-Bald BAER team August 16-24, 2014. The BAER soil assessment methodology is discussed above.

In addition to the field work conducted by the BAER team soil scientists, the Bald Project area was visited by the LNF soil scientist and district and Forest hydrologists during the fall and winter of 2014-15. The purposes of field work were to: (1) validate the Soil Survey mapping, (2)

gather information on site-specific soil properties, (3) assess current soil conditions as affected by past management activities and wildfire, and (4) develop predictions on soil response to the proposed treatments.

Field work consisted of walk-through inspections in various units and soil monitoring along five transects in Units 152, 102, 1013, 121, and 1034. Units 1013 and 1034 are no longer part of the proposed action but these soils represent other parts of the project and are considered valid for use in this analysis. The soil monitoring followed the national soils monitoring protocol (Page-Dumroese, 2009).

AFFECTED ENVIRONMENT

GEOLOGY AND SOILS

The project area is located on the east side of the southern Cascade Mountains. See the Bald Environmental Assessment for a description of the project geography. Soil parent materials in the project activity areas are from various volcanic sources: basalt, andesite, rhyolite, cinder, and tephra. Soils from rhyolitic parent material are specifically listed in the Forest Plan as erodible (Appendix 1-4). To simplify the analysis, soil map units comprising less than 0.5 acre total were eliminated from consideration. Soils and underlying rock are generally porous, causing precipitation to percolate deeply rather than contribute to streamflow.

The dominant soil surface texture is loam with varying rock contents, covering about 67 percent of the project area. Sandy loams dominate about 33 percent of the area.

Erosion hazard rating is dependent on slope, texture, depth, and soil cover; rock fragments greater than ¾ inch count for cover on bare soil. Over 35 percent of the ground-based project activity area is dominated by soils with at least 15 percent rock in the surface soil. Following wildfire, rock cover is very important to the protection of soils from erosion since the other soil cover, the forest floor and low-growing vegetation, are largely gone where SBS was moderate or higher. EHR is calculated here assuming bare soil conditions to reflect maximum EHR associated with moderate and high burn severity areas where little soil cover remains. See Appendix 1-4 for maps of the highly erosive soils within proposed treatment units. See Appendix B for the table of soils in the project mechanical activity areas and their EHR, and Appendix C for subsoil characteristics and their compaction hazard ratings.

CURRENT SOIL CONDITIONS

Factors influencing current soil condition are soil type, residual effects of past management, and recent wildfire effects. The assessment of current soil condition is based on field observations, the BAER assessment, and an evaluation of past logging activities in the project area.

WILDFIRE EFFECTS

The Bald Fire burned 31,324 acres on the Lassen National Forest. Approximately 75 percent of the area burned at very low to low SBS, 23 percent burned at moderate SBS, and 1 percent at high SBS. Within the Bald Project treatment areas, approximately 60 percent burned at low or very low SBS, 38 percent at moderate, and 3 percent at high SBS. The high and moderate SBS classes have evidence of severe soil heating in a patchy distribution. Despite widespread

complete vegetative mortality, there was an overall lack of high SBS due to rapid fire progression and thus short residence time for severe soil heating effects. The seedbank and infiltration characteristics are largely intact for the moderate SBS, so natural recovery should be normal and acceptable for the resource. The low and very low severity classes (75% of the activity area) still have good surface structure, contain intact fine roots and organic matter, and should recover in the short-term once revegetation begins and the soil surface regains cover.

Water repellency is a phenomenon of some dry soils in which water is very slow to infiltrate into the soil profile. The condition is commonly exacerbated by wildfires and is evaluated as part of the BAER assessment. In the Bald Fire, water repellency was common, varying from slight and surficial in low SBS to severe at two to four inches depth in high SBS; repellency was generally patchy everywhere, so it is not expected to greatly exacerbate runoff production. Unburned areas had little repellency. Fire-induced soil water repellency diminishes over time and is mostly gone within two years (Larson et al., 2009).

Desired Condition

The National Forest Management Act (NFMA) of 1976 recognized the fundamental need to protect, and where appropriate improve, the quality of soil (NFMA, 1976). NFMA requires that the Forest Service manage lands so as not to impair their long-term productivity. Further, activities must be monitored to ensure that productivity is protected. NFMA led to subsequent regulation and policy to execute the law at various levels of management.

The National Soil Management Manual (USFS, 2010) defines soil productivity and components of soil productivity, and establishes guidance for measuring soil productivity. In determining a significant change in productivity, a 15 percent reduction in inherent soil productivity potential will be used as a basis for threshold values. Developed at the Regional and Forest levels, these thresholds are known as Soil Quality Standards.

The management direction in the Land and Resource Management Plan (LRMP) for the Lassen National Forest (LRMP, 1993), the Sierra Nevada Forest Plan Amendment Record of Decision, (SNFPA 2004), and LNF Forest Supervisor directive dated June 11, 2007, provide the following soil quality standards. These standards constitute the immediate, foreseeable, and long-term desired conditions for the Bald Project:

- The areal extent of detrimental soil disturbance will not exceed 15 percent of the area dedicated to growing vegetation (LRMP, 1993, p. 4-27).

- Soil cover is sufficient to prevent the rate of accelerated soil erosion from exceeding the rate of soil formation (LRMP, 1993, p. 4-27).

- Soil porosity is at least 90 percent of the measurements found under undisturbed or natural conditions (Tippin, 2007).

- Organic matter is present in amounts sufficient to prevent significant short or long-term nutrient cycle deficits (LRMP, 1993, p. 4-27).

- Soil organic matter in the upper 12 inches of soil is at least 85 percent of the total soil organic matter found under undisturbed or natural conditions (LRMP, 1993, p. 4-27).

- Litter and duff occurs on at least 50 percent of the area (LRMP, 1993, p. 4-27).

- Large woody material (LWM), when occurring in the forested area, is at least five logs per acre in contact with the soil surface; and represents the total range of decomposition (LRMP, 1993, p. 4-27).

- Restore all substantial areas of significantly degraded soil (LRMP, 1993, p. 4-27).

CURRENT STATUS OF INDICATORS

Soil Cover (for erosion prevention): Loss of soil cover from the wildfire is the primary soil concern identified in the proposed activity area, with the consequence of elevated erosion potential. The units that experienced moderate or high soil burn severity (SBS) were without organic soil cover immediately following the burn. At 150 observation points within the Bald Project area 76 percent of the points had less than 50 percent soil cover. The majority of existing soil cover is in the form of rock, since most of the forest floor and vegetation burned in the fire.

In the fall of 2014, abundant needlecast was observed in low and moderate SBS units where crown fire did not occur. However, in the monitoring transects very little forest floor was observed. Twenty-five percent of observation points had enough needles and other fine woody material to contribute to erosion prevention. Needlecast has been demonstrated to reduce erosion rates (Pannkuk and Robichaud, 2003).

Although vegetative soil cover was mostly consumed in the moderate and high SBS areas, newly sprouting shrubs and seedlings were observed in some units and will contribute to soil cover as they grow and new seedlings and sprouts emerge. Observations made in the January of 2015 showed 25 percent of 150 observation points had at least one live plant growing on the soil surface.

Soil erosion is an inevitable consequence of wildfire. Following the fall and winter rains of 2014-15, sheet and rill erosion was observed in units where soil cover was low or non-existent. Erosion, either sheet or rill, was occurring at 30 percent of the monitoring points in the units observed.

Soil Porosity (Compaction): Porosity loss caused by heavy equipment compacting soil as it moves across the land can inhibit root growth and water infiltration. Residual porosity loss from past management is concentrated on main skid trails and landings. Porosity loss was assessed at 150 observation points in February 2015. This was possible due to unusually warm weather preventing the ground from freezing. Porosity loss due to mechanical operations was observed at 13 locations. Of those, four were considered detrimentally compacted.

Litter and duff: Litter and duff are a major nutrient reservoir in conifer forests and provide physical protection to the mineral soil from raindrop impact. They are currently lacking in

substantial portions of the project area, particularly in the moderate and high SBS areas. At all of the Bald monitoring points the forest floor had been consumed. A new forest floor is beginning to form where tree crowns were not completely burned in the fire and needlecast is now occurring. Twenty-five percent of the 150 observation locations had enough needles and other fine woody material on the ground to be a factor in erosion prevention. Rock contributed to soil cover at 40 percent of the locations.

Soil organic matter: Soil organic matter (SOM) is the organic matter found concentrated within the upper layer of mineral soil, or topsoil. It is comprised of stable organic molecules at the last stages of decomposition. Soil organic matter is one of the most important constituents in forest soils due to the positive effect it has on soil structure, water holding capacity, infiltration rate, nutrient retention, and nutrient cycling. SOM is generally present in sufficient enough amounts within the Bald Project area to avoid the detrimental physical and biological soil conditions that result when it is removed. This is because only a small portion of the area burned at high SBS.

SOM can be buried when soils are displaced by equipment turning or during earthmoving activities. Small isolated patches of displacement are not considered to be detrimental since the SOM is still onsite. Tillage operations like ripping are not considered detrimental since the SOM remains onsite and since breaking up compacted layers by tillage is considered a net benefit. During monitoring of the Bald Project ,past displacement was minimal and was noted at one location out of 150.

Large Woody Material: LWM is greater than 15 inches in diameter and 10 feet in length. Because down logs were consumed in the fire, few logs remain on the Bald Project landscape. Less than one log per acre was observed during soil monitoring. The number of down logs will increase as trees killed in the fire fall to the ground.

SUMMARY OF EXISTING SOIL CONDITION

Soil cover for erosion prevention is deficient in areas that burned at high and moderate SBS due to consumption of litter and duff, woody material, and vegetation. As a result of this loss of soil cover, sheet and rill erosion occurred with the fall and winter rains following the fire. The greatest erosion is occurring on steeper areas where both the forest floor and needles on the trees were consumed, and there is little rock cover. Litter and duff is deficient in high and moderate burn severity areas, as is LWM. Soil organic matter is considered sufficient in the 75 percent of the project area with low burn severity. Legacy porosity loss is minimal in the project areas monitored.

ENVIRONMENTAL EFFECTS

BOUNDING OF EFFECT ANALYSIS

For soil resource assessment, the analysis area is bounded by the project activity units where ground disturbing activities take place. Soil quality standards are intended to be used at this scale to determine project effects on key soil functions, focusing here upon on-site erosion potential, soil productivity, and hydrologic function.

The analysis is further bounded in time by the foreseeable future period during which effects of this project could persist as detectable, significant effects. Some soil features, such as cover, can recover rather quickly. Others, such as compaction, can persist for decades. In general, effects are discussed as short-term (1 to 5 years) or long-term effects. For cumulative effects, the analysis is bounded in time by past, present, and reasonably foreseeable future projects.

Alternative 1 – Proposed Action

DIRECT EFFECTS OF THE PROPOSED ACTION

Direct effects of the proposed action differ by harvest method and current post-fire site conditions. Expected effects are inferred from field review of current site-specific conditions, knowledge of soil properties, and results of research. Expected effects are assessed with the intent and assumption that integrated design features (IDFs) and water quality best management practices (BMPs) are effectively applied. The following sections discuss general within-unit effects of the proposed action.

Area Salvage Harvesting and Hazard Tree Removal

Alternative 1 proposes 4,815 acres of roadside hazard removal and 3,632 acres of area salvage for a combined treatment equal to 27 percent of the project area. These treatments involve mechanical harvest of trees with feller-bunchers and use of skidders to move trees to landings, followed by a) unit-wide mechanical piling of woody debris in preparation for planting, then pile burning; or b) mastication; or c) broadcast burning. Effects of each treatment are discussed below.

The risk of impacts to soils in tractor salvage units is primarily determined from EHR and compaction risk rating (Appendices B and C). Compaction risk is important to consider in this project due to the higher vulnerability of bare soils to runoff from compacted ground.

Erosion risk is highest where bare soil EHR is high and SBS is moderate to high. Compaction hazard is highest where the subsoil has elevated clay percentages. See Appendix D for a list of Bald Project units that have high erosion hazard or high compaction hazard soils. These are also shown on maps in Appendix E and Appendix F. Mitigation of this risk is described below. Project implementers should use this information to aid in scheduling activities when these units will meet the LNF wet weather operations soil moisture guidelines, per IDF.

Effects of mechanical harvesting followed by machine piling

Soil cover (for erosion prevention): The direct effect of this treatment will be a moderate beneficial increase in soil cover from woody debris from felled trees. Some of that material will be removed during fuels piling, but the residual material would still amount to a net increase in soil cover. The erosion hazard for the treatment units ranges from moderate to high for the bare slopes found post fire. On skid trails over 20 percent slope, approximately 75 percent soil cover is required in addition to water barring to minimize erosion. On rhyolitic soils, if sufficient cover is not available, straw or other erosion control materials would be used. Although there will be an overall increase in plant cover due to shrub sprouting and seedling emergence of shrubs, grasses, and forbs prior to project implementation, recent research has shown that plant cover

will likely be less where equipment operates relative to unsalvaged ground (Wagenbrenner et al., 2015).

Overall soil cover is expected to increase as a result of tractor salvage. During the felling and moving of tree limbs, bark and needles break off and cover the soil surface. A tractor salvage unit that burned at high vegetation burn severity in the 2012 Chips Fire on the Lassen NF was monitored for soil cover before and after salvage harvest. Results showed a sizable reduction in the amount of bare ground after salvage harvest (Table 1).

Table 1. Soil cover before and after fire salvage harvest. Poker Chip Unit 1005.

	Pre-salvage		Post-salvage
	12/10/2012 n = 30	8/6/2013 n = 70	7/16/14 n = 147
% of points with > 50% bare soil	53	54	29
% of points with green plant	0	50	50

Both high and moderate SBS areas will require minimum retention of activity-generated organic materials for erosion control objectives. If post-activity cover is inadequate to prevent erosion in tractor units, the addition of slash or mulch cover may be necessary on a site-specific basis, per IDF.

Porosity: Mechanical treatments in general have the potential to cause detrimental levels of compaction. The compaction hazard rating of these soils ranges from low to high. Little compaction is anticipated except where machine traffic is highly concentrated, such as landings and primary skid trails. Soil monitoring in the project area showed little detrimental porosity loss where mechanical harvest had taken place in the last 30 years. IDFs limit tractor operations to periods when the soil is not wet, and there is a provision that will remediate excess compaction if it were to occur. Therefore, porosity loss is expected to be kept within standards.

Litter and Duff: Litter and duff are mostly absent from the moderate and high SBS areas and will be slowly replenished from needlecast where trees survived and from organic inputs from other plants over a longer time period. In the low burn severity areas litter and duff will be lost from skid trails and landings, but would continue to meet the standard of 50 percent areal extent. Where machine piling of fuels occurs, some litter and duff will be moved to the burn piles. This will be minimized by piling only as much woody material as necessary to meet fuels objectives, per IDF. In the Negro Gulch area, units on slopes over 20 percent would be grapple piled. Grapple piling has less chance of moving soil into burn piles and is less likely to cause compaction than dozer piling since it does not include multiple passes with machinery.

Soil Organic Matter: Soil organic matter will be largely unaffected by displacement associated with tractor yarding because the existing trail system will be used. The risk of a loss of SOM can

be high with machine piling because there is a potential to move soil into burn piles. The risk is reduced by piling as little material as necessary to meet site preparation objectives, per IDF, and using grapple piling on the more sensitive soils. High temperature fire, such as generated in burn piles, can cause loss of SOM directly under the piles. These losses would be superficial (top 2 – 3 inches) and limited in extent.

Large Downed Wood: Large downed wood will be left in sufficient amounts to meet Forest standards, per IDF. Within treatment units, substantial areas will be left unharvested and 54 percent of the project area will receive no treatment and would have more than sufficient large downed wood in the long-term.

Mastication

Mastication is the grinding of small trees and shrubs in place, leaving the wood chips on the ground.

Soil cover (for erosion prevention): Mastication would result in a beneficial increase in ground cover material.

Porosity loss: Masticating equipment is low-ground pressure and would not be expected to detrimentally decrease soil porosity when following IDFs.

Soil Organic Matter: Mastication will distribute wood chips and finer materials across the soil surface. Over time, a portion of this material would eventually break down into humus and become part of the organic matter within the topsoil.

Litter and duff: Where mastication occurs, the overall amount and thickness of litter and duff would increase.

Large Down Wood: Other than occasional disturbance to large down wood, particularly decay class 5 logs, this treatment would have no effect on large down wood.

Broadcast burn

Broadcast burning is a low intensity fire activity implemented when fuel moisture and weather conditions are optimal to prevent high intensity fire. This treatment would be applied across the project area, but only allowed to back into the edge of non-forested areas.

Soil cover (for erosion prevention): Prescribed fires are designed to leave some residual material to protect the mineral soil and maintain high infiltration rates, which minimizes potential erosion (Robichaud et al., 2005)

Porosity loss: Underburning would not impact soil porosity since it does not involve using heavy equipment.

Soil organic matter: Underburning would have no direct effect on SOM. Soil organic matter is located within the mineral soil where soil temperatures would not reach temperatures high enough to burn under controlled conditions.

Litter and duff: With the underburn there will be a net loss in litter and duff. This temporary loss of litter and duff would be restored over a short time period, two to three years, with new needlecast.

Large woody material: Some LWM would be consumed by the fire, particularly rotted logs. Over time LWM will be replenished as snags fall to the ground.

Area Fuels

Area fuels treatment would occur on 5,499 acres (18% of the project area) under Alternative 1, in addition to occurring where needed within the salvaged units. Machine piling of fuels in the proposed actions is primarily the use of tractors fitted with brush rakes to move surface fuels into piles that will later be burned. A subset of units in the Negro Gulch area would not have tractor piling as an option but would use grapple piling or mastication (see IDF 49 for a list of these units).

Soil Cover (for erosion prevention): This treatment would result in a loss of ground cover due to the removal of surface fuels. Project IDFs are in place to limit the amount of material being removed Monitoring of the Chips salvage units showed approximately 50 percent soil cover after salvage activities had occurred.**Porosity Loss:** Multiple passes of machinery increase the risk of detrimental porosity loss. By limiting the operating period to periods when the soil is not wet, and by piling as little material as necessary, porosity loss would be would be minimized, as specified in the project IDFs.

The need for post-harvest subsoiling to ameliorate detrimental compaction would be assessed and implemented on a site-specific basis per IDF.

Soil Organic Matter: The risk of a loss of SOM can be high with machine piling because there is a potential to move soil into burn piles. The risk is reduced by piling as little material as necessary to meet fuels and site preparation objectives. For grapple units, there is little risk of moving soil into piles.

High temperature fire, such as generated in brush piles, can cause loss of SOM directly under the burn piles. These losses would be superficial (top 2 – 3 inches) and limited in extent.

Litter and Duff: Machine piling would result in a loss of litter and duff. Within a few years, needles blown in from adjacent trees and needlecast from planted trees would restore lost litter and duff.

Large Downed Wood: Downed wood can be adversely impacted by machine piling; however, the proposed action states to leave logs greater than 15 inches in diameter where they exist. Within treatment units, substantial areas will be left unharvested. These dead trees will provide LWM on the soil as they gradually fall over.

Area Fuels - Hand Treatment Only

Hand treatments have minimal impact on soils since no heavy equipment is involved. This would occur in scattered polygons, particularly on slopes steeper than 35 percent, and within some Riparian Conservation Areas.

Planting only would occur on 417 acres, approximately 1% of the project area.
Reforestation involves hand work with minimal soil disruption and effects.

SUMMARY OF DIRECT EFFECTS OF THE PROPOSED ACTION

An estimated 14,363 acres (46% of the project area) would be treated under Alternative 1. Ground-based mechanical treatments have the potential to cause detrimental disturbance to soil in the post-fire environment. As discussed, on-site direct effects from the proposed action are expected to be minimal with the project IDFs in place. The potential for activities to generate additional soil cover in the form of woody debris in areas with moderate and high SBS is considered a net benefit for burned areas, but the loss of vegetation resulting from mechanical operations is a short-term adverse impact. After fuels treatment has occurred natural regeneration, as well as planting, would increase vegetation cover in the long-term. Fifty-four percent of the project area would not have treatments. These areas are scattered across the project area and include 20 percent of the units that would not be treated. These areas would recover naturally over time.

Ten years of soil monitoring on the forests of the Herger-Feinstein Quincy Library Group (HFQLG) pilot project (which includes the Lassen NF) have demonstrated the effectiveness of Forest Service implementation methods in preventing detrimental soil effects resulting from vegetation management activities in the Northern Sierra Nevada and Southern Cascades. Similarly, BMP monitoring during the same period has demonstrated that the Lassen has been highly effective in its protection of soils and water quality through proper implementation of BMPs (HFQLG, 2011).

INDIRECT EFFECTS OF THE PROPOSED ACTION

Soil erosion and impaired hydrologic function have a general potential to create indirect effects. Indirect effects of erosion and compaction are off-site effects upon watershed hydrology and/or water quality. Damaged soil hydrologic function, via compaction, can lead to increased runoff, which can affect the quantity, timing, and flashiness of stream flows during precipitation events. As discussed, the adverse direct effects associated with the proposed activities are expected to be mitigated by use of IDFs protecting both soils and hydrology, so indirect effects would be accordingly minimal.

CUMULATIVE EFFECTS OF THE PROPOSED ACTION

The cumulative effects assessment area for the soils resource is bounded in space within the proposed activity area, because this is where the full extent of soil disturbing activities takes place. Effects analysis includes past, present, and reasonably foreseeable future actions within that area.

Past, Ongoing, and Reasonably Foreseeable Future Actions (PORFFA)

Past, present, and future ground disturbing activities in the Bald Project area are listed in the Bald PORFFA (Bald Project EA Project Record). Ground-based mechanical vegetation management activities have occurred within the Bald project area over the past decades. Future ground disturbing activities include the activities planned in the Bald Project proposed action and the Eastside Underburn. Underburning tends to be patchy in distribution and at lower intensity than wildfire. Only minor local and short-term effects would be expected from underburning. No long-term adverse impacts would be expected.

Cumulative Effects Determination
Based on limited field observations and the PORFFA report, past projects have left some degree of persistent porosity loss (compaction). The adverse effects of the proposed action are expected to be minimal due to IDFs that will minimize the detrimental compaction that may be expected in small areas and remediate areas that may exceed the LRMP standard.

In improving soil cover for areas currently lacking it, there will likely be a moderate short-term benefit in reducing overall erosion potential within the project area, while soil productivity and hydrologic function are maintained. In the long-term, as vegetation is planted and comes in naturally, soil cover would approach the high soil cover naturally found within the project area.

The proposed action would maintain soil productivity and function within required standards. Therefore, the proposed action in combination with past, ongoing, and reasonably foreseeable future actions will not produce adverse cumulative effects to the soil resource.

Alternative 2 – No Action

EFFECTS OF THE NO ACTION ALTERNATIVE
Direct effects of the No Action alternative would have a minimal effect on the soils, as soil disturbing project activities would not take place except to cut down hazard trees along roads. This could occur on up to 4,736 acres (15%) of the project area. Direct effects to soils would be minimal. Soil cover for erosion protection would gradually increase as low-growing plants establish and spread. This would occur more slowly than under Alternative 1, where ground cover increases more quickly due to debris and branches adding to soil cover during salvage and fuels activity. Debris from dead trees would fall and provide some soil cover. Present compaction levels and soil hydrologic function would remain unchanged. Organic matter dynamics and nutrient cycling would continue to recover naturally once vegetation becomes re-established. Some areas will be left lacking surface cover, while other areas will have high concentrations of fuels, putting soils at greater risk for adverse effects from the next fire.

Indirect effects of the No Action alternative would be the continued short-term erosion, particularly for steeper areas with moderate and high SBS, until hydrophobicity diminishes and ground cover naturally increases. In the long-term, areas with moderate and high SBS would have high fuel loadings, with a corresponding elevated hazard of detrimental soil effects in the event of wildfire.

Alternative 3 - Roadside Hazard Only

This alternative would treat 4,736 acres along roads (15% of the project area). Where treated, the effects would be similar to those described above under Alternative 1, as related to the removal of hazard trees with mechanical harvest, followed by machine piling of fuels generated in removal of the trees. Treatment of other fuels would not be expected to occur. The 85 percent of the project area left untreated would recover naturally with the effects discussed above in Alternative 2.

COMPARISON OF ALTERNATIVES

For erosion potential, the difference between the action and no action alternatives would probably not be quantifiable given the large changes to soil cover, organic matter, and large downed wood resulting from the effects of the fire. First-year post activity erosion could be slightly elevated under Alternative 1 due to ground disturbance. Alternative 1 adds more groundcover for a net improvement, but at the same time, tends to set vegetation back for a couple of years near skid trails and other disturbed areas. Alternative 2 would have less ground disturbance, so vegetation would become established more quickly in many areas but would have less ground cover than found in the salvage units. Alternative 3 would be intermediate in effects between Alternative 1 and 2.

Future high-intensity fire hazard due to unburned fuels in the Bald Fire area represents a threat to soil resources within the project area. The removal of future fuels through harvest and through piling and burning of woody debris will reduce that risk. The No Action alternative would do nothing to alleviate the hazard and Alternative 3 would do little to alleviate the hazard.

The proposed action alternative does not pose a substantial short-term detriment to soils, and it provides some medium to longer-term benefits for soils and other resource management objectives.

SUMMARY EFFECTS DETERMINATION

The Bald Fire caused large scale soil disturbance and a pulse of erosion, albeit natural, with consequential impacts to soil productivity and water quality. Treatments under Alternatives 1-3 would be for 46 percent to 15 percent of the project area. Soil IDFs and BMPs are in place to protect soils. Management requirements for soils would be met under all alternatives.

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Appendix A.

Soils standards and guidelines. Lassen National Forest	
SOILS – Strategy	
LRMP	Forest wide Objectives
Ch. 4, Sec. E, p. 4-27, SO a. (2-5)	2. Field-verify existing reconnaissance soil resource inventory data (Order 3 surveys) for each land-disturbing project.
	3. Conduct detailed soil surveys (usually Order 2) for all project areas that have an erosion hazard rating of "high" or "very high" (according to the R-5 rating system), landslides or unstable areas, potential re-vegetation or regeneration problems, active erosion, or a significant potential to contribute to cumulative degradation of water quality.
	4. Assess each proposed regeneration harvest area to assure the soil is capable of supporting the establishment of trees within five years.
	5. Assess each proposed re-vegetation area to assure the soil is capable of supporting the establishment of grass or brush within two years.
Ch. 4, Sec. E, p. 4-27, SO b. (1)	1. Restore all substantial areas of significantly degraded soil. (1) Identify, evaluate, and establish treatment priority areas of significantly degraded soils. Treat within two decades.
SOILS – Design Criteria	
SNFPA Source	Forest wide Standards and Guidelines
Salvage	
SNFPA ROD Appendix A, Part D, p. 52	Design projects to reduce potential soil erosion and the loss of soil productivity caused by loss of vegetation and ground cover. Examples are activities that would: (1) provide for adequate soil cover in the short term; (2) accelerate the dispersal of coarse woody debris; (3) reduce the potential impacts of the fire on water

	quality; and (4) carefully plan restoration/salvage activities to minimize additional short-term effects.
LRMP Source	Forest-wide Direction Standards and Guidelines
Ch. 4, Sec. E, p. 4-27, SO a. (1), (a)	a. The areal extent of detrimental soil disturbance (DSD) will not exceed 15 percent of the area dedicated to growing vegetation.
Ch. 4, Sec. E, p. 4-27, SO a. (1), (b)	b. Soil cover is sufficient to prevent the rate of accelerated soil erosion form exceeding the rate of soil formation.
Ch. 4, Sec. E, p. 4-27, SO a. (1), (c) and Errata Statement (June 11,2007)	c. Soil porosity is at least 90 percent of the measurements found under undisturbed or natural conditions.
Ch. 4, Sec. E, p. 4-27, SO a. (1), (d)	1. Organic matter is present in amounts sufficient to prevent significant short or long-term nutrient cycle deficits.
	2. Soil organic matter in the upper 12 inches of soil is at least 85 percent of the total soil organic matter found under undisturbed or natural conditions.
	3. Litter and duff occurs on at least 50 percent of the area.
	4. Large woody material, when occurring in the forested area, is at least 5 logs per acre in contact with the soil surface; and represents the total range of decomposition.
Ch. 4, Sec. E, p. 4-29, SO a.	7. Avoid tractor skidding on slopes greater than 35 percent and on soils with an erosion hazard rating greater than 9.

Appendix B. Erosion Hazard Ratings for Bald Project Soils in Mechanical Treatment Units

		EHR Rating for Bare Soil		
Map Unit	Map Unit Name	0-15% Slope	16-30% Slope	31-45% Slope
4	Aquolls-Durixerolls association, 0 to 15 % slopes.	Mod	High	High
5	Bobbitt- Brownlee-Alicel families complexes, 0 to 35 % slopes	Mod	High	High
6	Bobbitt family-Durixerolls association, 0 to 35 % slopes	Mod	High	High
7	Bobbitt family, moderately deep-Gwin family association,0 to 35 % slopes.	Mod	High	High
8	Bobbitt family, moderately deep-Gwin family association, 35 to 50 % slopes.	Mod	High	High
10	Bobbit-Holland families, Lithic Haploxeralf association, 0 - 15 % slopes	Mod	High	High
15	Brownlee-Bobbitt families association, 0 to 35 % slopes.	Mod	High	High
16	Brownlee-Skalan families association, 0 to 35 % slopes.	Mod	High	High
17	De Masters-Klicker families association, 0 to 35 % slopes.	Mod	High	High
19	Durixerolls, 0 to 15 % slopes.	Mod	Mod	High
20	Durixerolls-Bobbitt family, moderately deep association, 0 to 35 % slopes.	Mod	Mod	High
33	Inville-Patio-Trojan families association, 0 to 35 % slopes.	Mod	Mod	High
36	Inville-Wintoner families complex, 0 to 35 % slopes.	Mod	Mod	High
38	Inville-Yallani families complex, 0 to 35 % slopes.	Mod	Mod	High
43	Klicker-Keating families-Durixerolls association, 0 to 35 % slopes.	Mod	Mod	Mod
45	Klicker familiy-Klicker family very stony association, 0 - 35 % slopes	Mod	High	High
68	Pass Canyon family-Lithic Haploxeralfs, rhyolitic complex, 0 to 35 % slopes.	Mod	Mod	High
76	Rubble Land-Pass Canyon family-Bobbitt family, moderately deep association, 35 to 70 % slopes.			

113	Typic Xerorthents-Yallani family association, 35 to 50 % slopes.	Mod	Mod	High
121	Wintoner family-Aquolls-Patio family association, 0 to 15 % slopes.	Mod	Mod	High
125	Yallani-Patio families, rhyolitic complex, 15 to 50 % slopes.	Mod	Mod	High
126	Yallani-Portola families association, 0 to 35 % slopes.	Mod	Mod	High
201It	Jellycamp-Ollierivas complex, 2 to 9 % slopes	Mod	Mod	Mod

Appendix C. Bald Project units with high compaction hazard soils.

Map		Subsoil	% Rock	Compaction	
Unit	Soil	Texture*	Fragments	Hazard	Acres
4	Aquolls-Durixerolls association, 0 to 15 % slopes.	sicl	10	High	45
5	Bobbitt- Brownlee-Alicel families complex, 0 to 35 % slopes	l	7	Moderate	5034
6	Bobbitt family-Durixerolls association, 0 to 35 % slopes	c	12	High	631
7	Bobbitt family, moderately deep-Gwin family association, 0 to 35 % slopes.	v cb cl	12	High	24
8	Bobbitt family, moderately deep-Gwin family association, 35 to 50 % slopes.	v cb cl	12	High	192
10	Bobbit-Holland families, Lithic Haploxeralf association, 0 - 15 % slopes	l	10	Moderate	35
15	Brownlee-Bobbitt families association, 0 to 35 % slopes.	l	10	Moderate	809
16	Brownlee-Skalan families association, 0 to 35 % slopes.	l	10	Moderate	1951
17	De Masters-Klicker families association, 0 to 35 % slopes.	l	12	Moderate	726
19	Durixerolls, 0 to 15 % slopes.	c	12	High	40
20	Durixerolls-Bobbitt family, moderately deep association, 0 to 35 % slopes.	c	12	High	281
33	Inville-Patio-Trojan families association, 0 to 35 % slopes.	l	5	Moderate	1045
36	Inville-Wintoner families complex, 0 to 35 % slopes.	l	8	Moderate	143
38	Inville-Yallani families	l	20	Moderate	302

	complex, 0 to 35 % slopes.				
43	Klicker-Keating families-Durixerolls association, 0 to 35 % slopes.	c	12	High	123
45	Klicker familiy-Klicker family very stony association, 0 - 35 % slopes	cb l	18	Moderate	39
68	Pass Canyon family-Lithic Haploxeralfs, rhyolitic complex, 0 to 35 % slopes.	scl	5	High	577
76	Rubble Land-Pass Canyon family-Bobbitt family, moderately deep association, 35 to 70 % slopes.	scl	5	High	32
113	Typic Xerorthents-Yallani family association, 35 to 50 % slopes.	gr f sl	22	Moderate	19
121	Wintoner family-Aquolls-Patio family association, 0 to 15 % slopes.	sicl	10	High	1
125	Yallani-Patio families, rhyolitic complex, 15 to 50 % slopes.	gr sl	35	Moderate	2182
126	Yallani-Portola families association, 0 to 35 % slopes.	gr f sl	22	Moderate	241
201It	Jellycamp-Ollierivas complex, 2 to 9 % slopes	c	7	High	18

* Subsoil texture is the most limiting component of the map unit in the 4" to 12" zone.
c = clay; cb = cobbly; f = fine; gr = gravelly; l =loam; s = sandy; si = silty; v = very

Appendix D. Bald Units with elevated soil hazards.

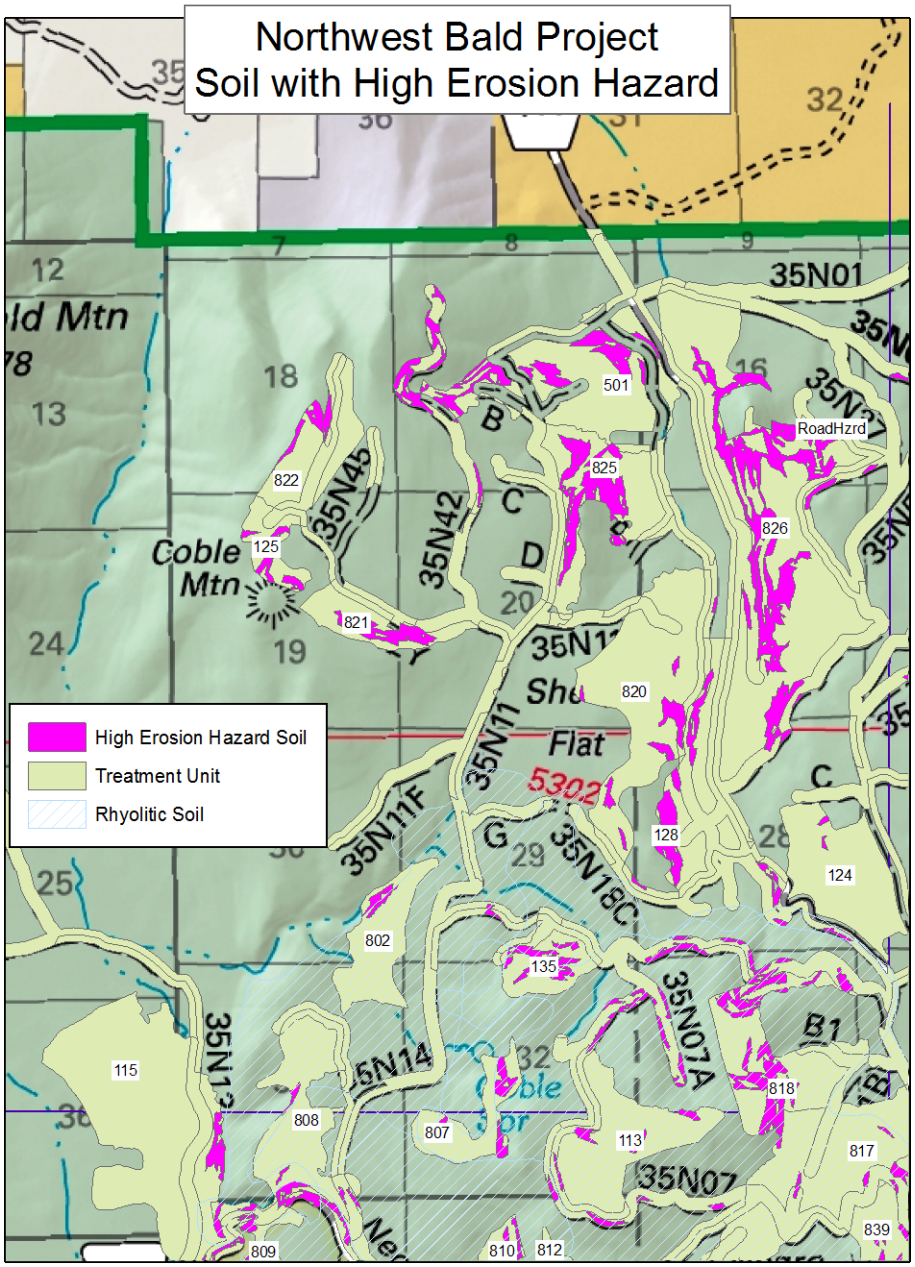
The following Bald units have portions of **high erosion hazard** soil.
See Erosion Hazard Maps (Appendix E-1, E-2, E-3 & E-4) for locations

112	501	818	836
113	506	820	837
115	802	821	839
124	807	822	842
125	808	825	851
128	809	826	852
135	810	831	855
140	812	832	856
142	814	833	112-157
147	817	834	RoadHzrd

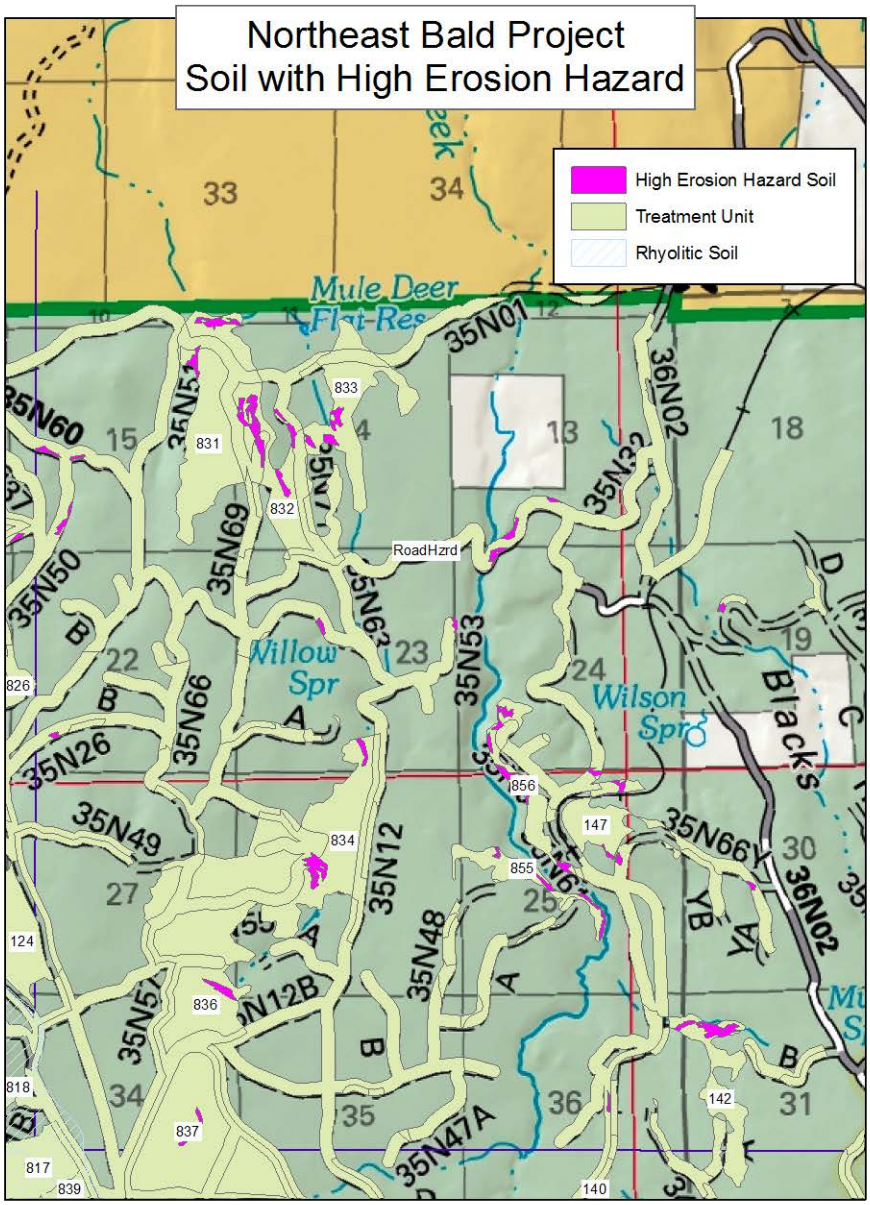
The following Bald units have portions of **high compaction hazard** soil.
See Compaction Hazard Map (Appendix F) for locations

103	143	822	858
105	147	834	861
106	148	840	862
107	166	842	864
108a	169	846	864R
116	505	847	RoadHzrd
120	802	849	
122	804	853	
123	810	856	
141	812	857	

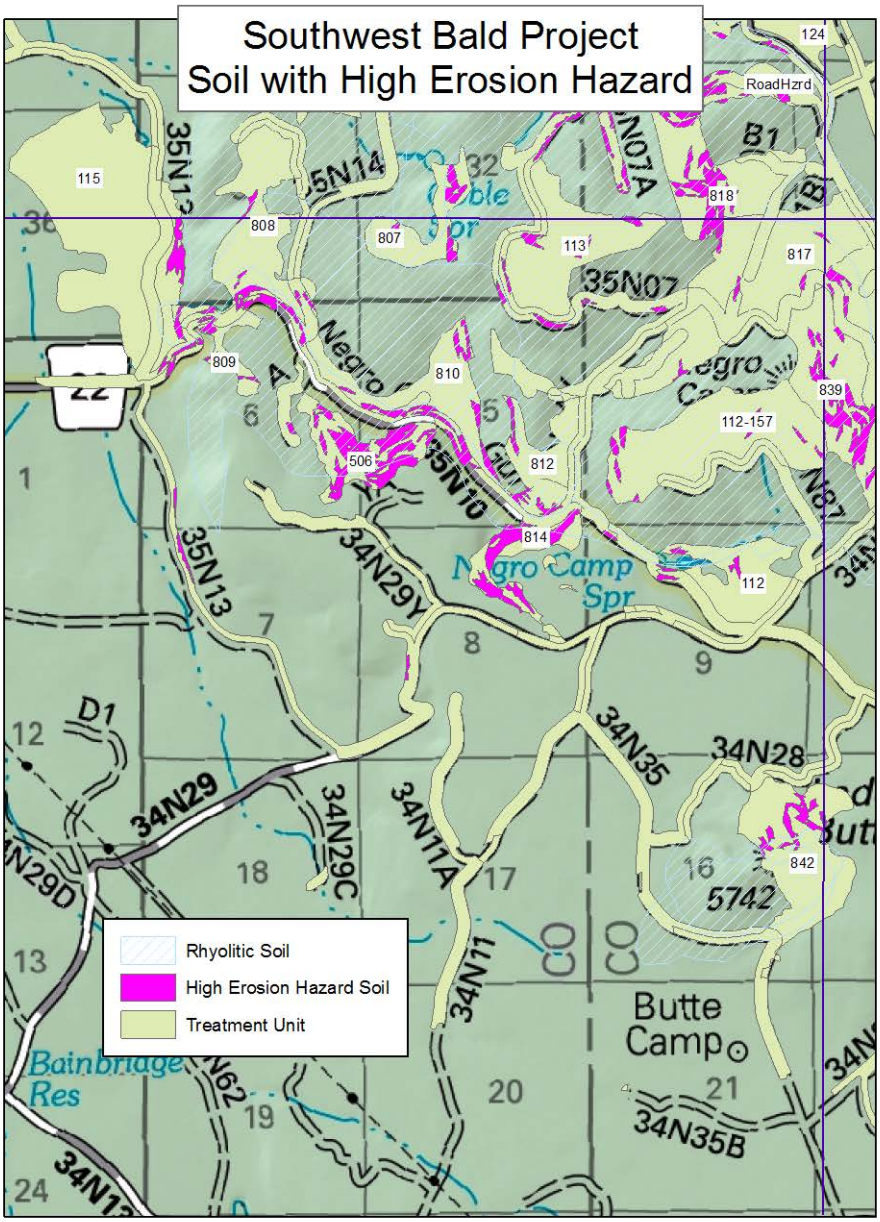
Appendix E-1. Northwest Bald Project High Erosion Hazard Soils.



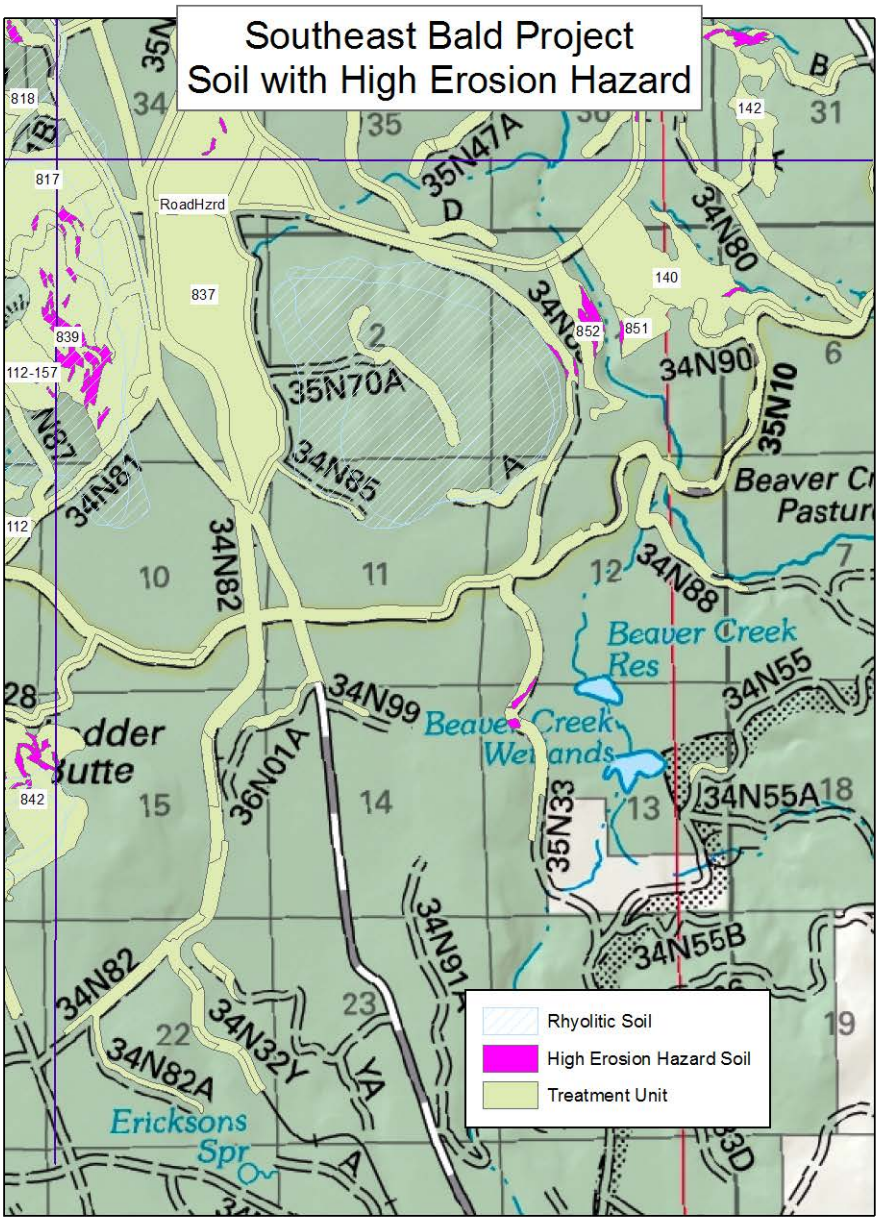
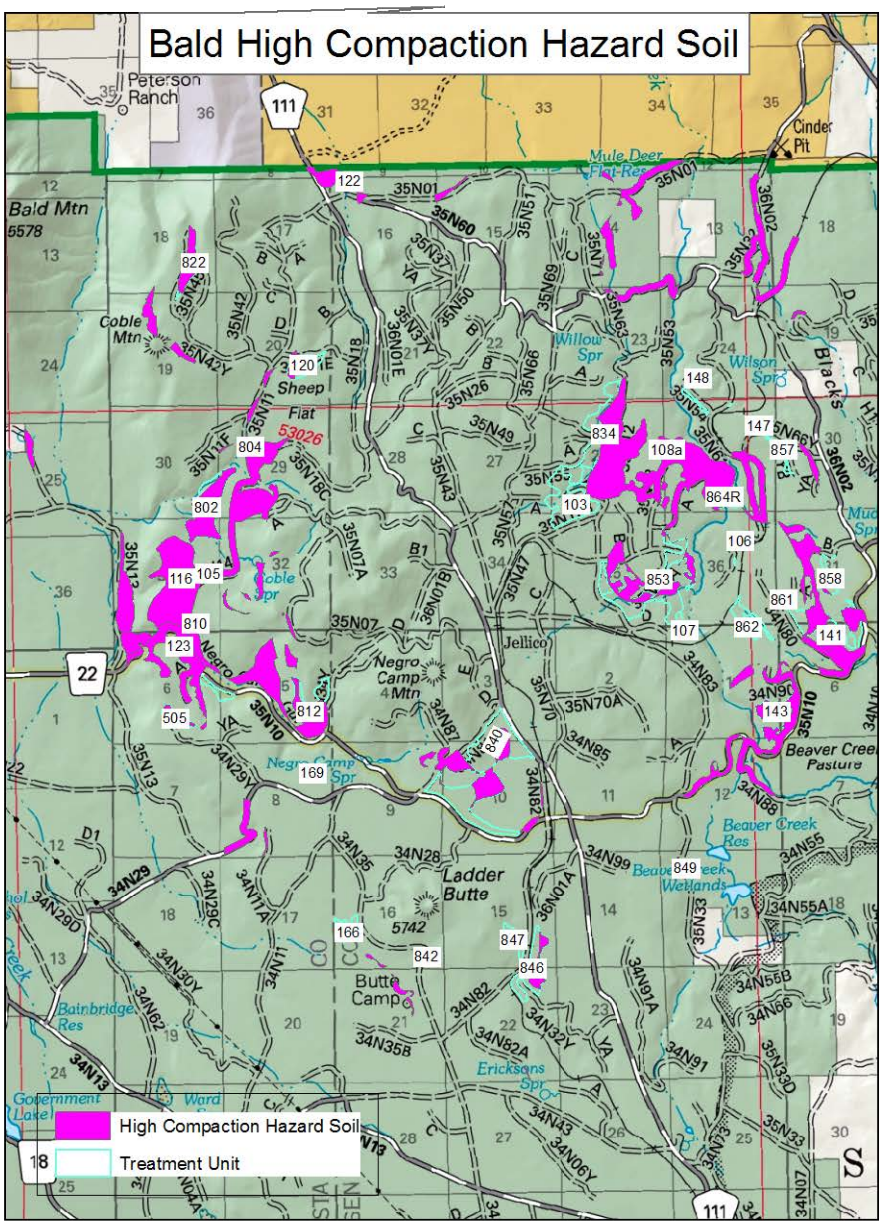
Appendix E – 2. Northeast Bald Project High Erosion Hazard Soils



Appendix E – 3. Southwest Bald Project High Erosion Hazard Soils



Appendix E – 4. Southeast Bald Project High Erosion Hazard Soils



Appendix F. Southeast Bald Project High Compaction Hazard Soils