Alternative 2a - Environmental Consequences for Soils

(Note: the following discussion of effects is based on the discussion of the direct and indirect effects of Alternatives 2 and 3 on soils, which is found on pages 77 through 86 of the DEIS. Updates to the effects discussion reflect the proposed activities under Alternative 2a described in FEIS Chapter 5).

Direct and Indirect Effects

As compared to Alternatives 2 and 3, Alternative 2a reflects changes in design criteria to further minimize effects to the soils resource:

- Units 1, 2, 3, 4, 11, 12a, 17, and 32 would be harvested in the winter to ensure soil protection, in addition to previously proposed winter harvest in units 13, 13a, 18 and 20.
- Soil conditions in Units 1, 2, 3, 18 and 20 would be monitored between the harvest and fuels treatment to determine if mitigation and restoration work is needed to make sure the final unit conditions do not exceed 15% detrimental disturbance. Such activities are committed to and would be funded using Brush Disposal (BD), Stewardship Retained Receipts, or other sources. Rehabilitation activities would be limited to dry soil conditions, normally July 15 – September 15, unless otherwise approved by the soils specialist.
- Access to Units 1, 2, 3, and 4 was changed to better utilize existing temporary roads and skid trails.

The primary impacts to soils from the proposed treatments are related to timber harvest and mechanical fuel treatments. A comparison of harvest and fuel treatment acres is displayed below:

FEIS Appendix 2, Table 1. Comparison of harvest systems and fuels treatments

Treatment	Alternative 2	Alternative 3	Alternative 2a
Summer Tractor	606	534	251
Winter Tractor	158	158	412
Skyline	274	315	192
Tractor/Skyline Swing	0	0	52
Helicopter	182	117	0
Grapple Piling	692	203	248
Spot Grapple Piling	20	5	60
Underburning/Machine Fireline	191	393	402

Another result of the activities is the loss of forest canopy associated with timber harvest treatments. Roughly half of the timber harvest specifies regeneration harvest, while the other half is salvage or commercial thinning where a forest canopy is retained. Impacts to soils may occur due to changes in solar radiation and accompanying shifts in understory vegetation. Timber harvest and burning may also incur soil erosion though the abundant groundcover limits erosive overland flows. Field observations found erosion rare and primarily associated with roads and not within timber harvest areas. The effects of precommercial thinning would be beneficial, increasing fine and coarse woody litter, increasing soil nutrients and ground cover. No adverse affects to soils productivity are expected; therefore, the Precommercial thinning units will not be discussed further.

General Effects Related to Timber Harvest

The impact from timber harvest activities typically results in compaction and displacement of topsoil from skidding operations and landing construction. The Kootenai NF has monitored soil disturbance over the past 20 years, primarily on activities in previously undisturbed areas using standard best management practices. Data summaries of soil monitoring activities completed by the Kootenai National Forest are displayed in Table 2 below.

FEIS Appendix 2, Table 2. KNF monitoring results of detrimental soil disturbance 2000 – 2005. (Kuennen 2006)

Category	Average 5-Year Detrimental Soil Disturbance
Skyline/Cable	1
Tractor (Summer)	8
Tractor (Winter)	4
Helicopter	0
Excavator Piling	2
Machine Fireline	1*

*Detrimental soil disturbance percent is listed but not added to predicted values in Table 3 below since this monitored activity is included in harvest and/or piling monitoring results

Overall, monitoring summaries indicate that tractor operations were within regional guidelines of 15 percent detrimental disturbance for treatment units (Kootenai Forest Plan Monitoring Report 1995-2004; Kuennen 2005). Ranges in tractor related soil disturbance typically vary according to soil moisture and machine operator (Grigal 2000, Williamson and Nielson 2000). Most of the compaction occurs within one machine pass, although bulk densities generally do not exceed root limiting bulk densities until three passes (Williamson and Nielson 2000).

Field reconnaissance found effects of tractor-based logging was higher on compact glacial till soils along benches and foot slopes (Units 1, 2, 3, 4, 13, 13a) compared to belt rock controlled hill slopes. Soil disturbance was typically associated with past temporary road building and bench cut skid trails rather than dispersed compaction. Specific restoration activities and design features identified in Table 3 address these existing conditions, and are designed to avoid additional impacts from proposed activities.

The direct effects of harvesting are tied to the amount of mechanical traffic from harvest, yarding and slash piling following treatment. The ash cap soils of the Grizzly project area may compact easily where surface rock is absent in the upper profiles (Page-Dumroese 1993). These ash cap soils may also be susceptible to erosion where soils are displaced and ground cover lost. Based on field observations of the project treatment units, erosion effects appear unlikely due to the strong vegetative regrowth potential. Also, the high rainfall and fog supplement growth with relatively low rainfall intensity (WRCC 2006).

Direct Effects of Tractor Harvesting

Higher levels of soil disturbance from tractor yarding are more likely to occur on slopes greater than 40 percent during non-winter periods of operation (Kuennen 1998). Overall, the project design mitigates this hazard by generally limiting tractor operations to 40 percent slope or less (BMPs, Appendix D). Units 33, 34, 40, 43, 44, 45, 46, 47, and 50a (based on ground verification of slopes) have some areas where slopes range from 40 to 50 percent. Specific design features identified in Chapter 2 of the DEIS to delineate these areas as special treatment areas to restrict equipment, and skyline logging systems designations, would prevent detrimental disturbance on these slopes. There are seven Forest landtypes that are considered ‘sensitive’ (102, 112, 325, 351, 365, 370, and 520). The sensitive landtypes that occur within the analysis area are landtypes 102 and 351, which comprise 177 acres, or less than 1 percent of the project area. An analysis of the proposed activities found that there is no proposed harvest on either sensitive landtypes or low productivity soils under any of the action Alternatives (see Landtypes map in this appendix and soils section of the project file). No landslide risk was identified in any of the proposed units for the action alternatives. Overall disturbance in these steeper units would not exceed 15 percent detrimental disturbance, based on past monitoring results (Kuennen, 1998, 2005) and existing levels of disturbance (less than 5 percent existing).

Because of existing detrimental soil disturbance, Units 1, 2, 3, 4, 11, 12a, 13, 13a, 18, 20, and 32 would be restricted to winter harvest (skidding on frozen ground) to minimize additional impacts to soils. Units 12 and 15 are dropped in Alternative 2a. For Units 1, 2, 3, 18 and 20, existing levels of detrimental disturbance exist due to existing skid trails, and excavated trails. Specific design features for these units include use of the least impactive treatments (harvest on frozen ground, underburning where feasible) to minimize increased detrimental disturbance, and restoration of existing skid trails. Winter harvest was identified due to the depth of fine soils and/or the higher soil moisture. Monitoring on the adjacent Idaho Panhandle NF shows reductions of 3 to 5 percent in detrimental disturbance using winter tractor harvest as opposed to summer tractor harvesting (Niehoff 2002). Monitoring on the Kootenai NF shows an average reduction of 4 percent in detrimental disturbance using winter tractor harvest as opposed to summer tractor harvesting (Kuennen 2003; Kuennen 2008, pers. Comm.). See Table 2 above. Restoration activities would occur during the drier part of the year, July 15 to September 15, unless otherwise approved by the district hydrologist.

The very moist conditions in the Yaak can increase compaction risk since silt loam soils are more susceptible to rutting and compaction when wet (Page-Dumroese 1993, Seigel-Issem et al. 2005). Most of the soils in the Grizzly project area have high rock content that reduces compactive forces from mechanical equipment. However, Units 3, 13 and 13a have areas where terrain rock is minimal within the ash topsoil and soils are moist given the footslope proximity. To minimize compaction risk, tractor yarding in Units 13 and 13a would be restricted to frozen soils to protect soils. Unit 3 was reviewed by the KNF Forest Soil Scientist, and upon consultation with district specialists familiar with area conditions, found winter logging operations feasible for these units. This activity would be closely monitored to make sure that harvest only occurs when the ground is frozen . In addition, Unit 3 has a design feature to identify leave islands around wet areas where equipment is restricted (special treatment area). These special treatment acres would also provide habitat for sensitive species.

The negative impacts of roads on soils and ecosystem processes in general are well-documented (Forman and Alexander 1998, Trombulak and Frissel 2000, Gucinski et al. 2001). Gucinski et al. (2001) outline these effects as removing and displacing topsoil, altering soil properties, changing soil microclimate, and accelerating erosion. While the Kootenai area has extraordinary growth potential with high rainfall, the existing skid trails in these units still have compacted conditions and stunted tree growth. Trees are dense and much lower in height with lateral rooting compared to similar aged regeneration off the roadways. While skid trail obliteration may have mixed results, the overall impact would reduce erosion potential by restoring natural surface and subsurface hydrology (Foltz and Maillard 2004, Switalski et al. 2004). In addition, placing slash on the surface would restore groundcover and promote vegetation growth (Clearwater NF Monitoring, USDA Forest Service 2003) to restore soil processes.

In general, the estimates of detrimental and cumulative disturbance in the activity areas are based up the following assumptions:

- To avoid increasing the amount of compacted areas in units, design features identified in FEIS Appendix 1 would require the use of existing skid trails where possible to minimize any additional increases in compaction. Depending on the results of post-harvest monitoring, Units 1, 2, 3, 18, and 20 may require rehabilitation of major skid trails by scarifying, seeding and placement of slash to reduce compaction and minimize erosion. Multi-year sampling of soil compaction values to monitor both the pre- and post-harvest detrimental soil disturbance values, as well as the post-restoration detrimental soil disturbance values, is anticipated to provide a sound comparison of micro-site soil improvements as related to vegetative rehabilitation over time. These values are anticipated to also provide information for similar future planned projects in identifying where rehabilitation activities should coincide with harvest operations.

- Examples of quantifiable reductions in detrimental soil disturbance related to restoration activities are available (Kindel & Furniss 2001, 2002; Rone 2007 and other restoration monitoring in the Soils section of the project file). Such activities are expected to improve existing soil conditions with time. Existing research also indicates these activities would improve existing soil conditions (Foltz and Maillard 2004, Switalski et al 2004, Clearwater NF Monitoring, USDA Forest Service 2003).

- In addition to standard best management practices included in DEIS Appendix D, additional specific design features identified in the first bullet statement above would be implemented to mitigate existing disturbance and potential impacts from activities.

- Use of existing skid trails where possible would reduce the predicted increase (Kuennen, 2005) in compaction.

- Restoring groundcover (placing slash) over rehabilitated skid trails would improve soil quality by reducing erosion, providing nutrients, and protecting vegetation growth.

- All restoration activities identified would improve existing detrimental soils conditions, meeting Regional policy of a net improvement in soil quality.

Table 3 on the following pages displays the existing soils condition by unit, the predicted increase in detrimental effects from the proposed activities, and the specific design features identified to mitigate the detrimental effects. The prediction of detrimental effects for the action alternatives is based upon KNF monitoring results from 2000-2005 (Kuennen 2006).

FEIS Appendix 2, Table 3. Existing and Predicted Cumulative Soil Disturbance for the Action Alternatives - replaces DEIS Table 24.

Unit #	Activity Area (acres)	Proposed Actions	Proposed Logging Systems and Fuels Treatment	Existing Detrimental Soil Disturbance (%)[1]	Action Alternatives 2/3/2a Potential Detrimental Soil Disturbance		Alt 2a Cumulative Disturbance Post Rehab[3]	Alt 2a Project Design Features To Protect Soils (Standard BMPs applied to all units)
					Predicted Disturbance%	Cumulative Disturbance % Post Harvest[2]		
1	17	CC/RES	Alt 2-T/UB Alt 3-T/UB Alt 2a-WT/UB	10	8/8/4	18/18/14	**8**	Winter harvest using old trails. Rehabilitate skid trails used for harvest if post-harvest monitoring values exceed 15%.[3]
2	16	CC/RES	Alt 2-T/UB Alt 3-T/UB Alt 2a-WT/UB	10	8/8/4	18/18/14	**8**	Winter harvest using old trails. Rehabilitate skid trails used for harvest if post-harvest monitoring values exceed 15%.[3]
3	20	CC/RES	Alt 2-T/SG Alt 3-T/SG Alt 2a-WT/SG	13	10/10/6	23/23/19	**13**	Winter harvest using old trails. Rehabilitate skid trails used for harvest if post-harvest monitoring values exceed 15%[3].
4	20	ST/RES	Alt 2-T/G Alt 3-T/G Alt 2a-WT/G	1	10/10/6	11/11/7	**1**	Winter harvest using old trails. Rehabilitate skid trails used for harvest if post-harvest monitoring values exceed 15%.[3]
10	9	CC/RES	Alt 2-T/G Alt 3-T/G Alt 2a-T/G	0	10/10/10	10/10/10		N/A
11	17	ST/RES	Alt 2-T/G Alt 3-T/G Alt 2a-WT/YT	7	10/10/4	17/17/11		Winter Tractor
12	7	ST/RES	Alt 2-T/G Alt 3-T/G Alt-2a-See Unit 11	6	10/10/see Unit 11	12		Unit 12 combined with Unit 11
12a	19	ST/RES	Alt 2-T/G Alt 3-T/G Alt 2a-WT/G	6	10/10/6	16/16/12		Winter harvest using old trails.
13	39	CC/RES	Alt 2-WT/UB Alt 3-WT/UB Alt 2a-WT/G	0	4/4/6	4/4/6		Winter harvest
13a	24	CC/RES	Alt 2-WT/UB Alt 3-WT/UB Alt 2a-WT/G	0	4/4/5	4/4/5		Winter harvest
15	33	CT	Alt 2-WT/UB Alt 3-WT/UB Alt 2a-Dropped	5	4/4/0	9/9/5		Unit Dropped
17	163 163 131	CT	Alt 2-T/G Alt 3-T/UB Alt 2a-WT/G	3	10/8/6	13/11/9		Winter harvest
18	28 28 20	CC/RES	Alt 2-WT/UB Alt 3-WT/UB Alt 2a-WT/UB	13	4/4/4	17/17/17	**12**	Winter harvest using old trails. Rehabilitate skid trails used for harvest if post-harvest monitoring values exceed 15%.[3] Deep rip landing
20	34	CT	Alt 2-WT/UB	12	4/4/6	16/16/18	**13**	Winter harvest using old trails. Rehabilitate skid trails used

Unit #	Activity Area (acres)	Proposed Actions	Proposed Logging Systems and Fuels Treatment	Existing Detrimental Soil Disturbance (%)[1]	Action Alternatives 2/3/2a Potential Detrimental Soil Disturbance		Alt 2a Cumulative Disturbance Post Rehab[3]	Alt 2a Project Design Features To Protect Soils (Standard BMPs applied to all units)
					Predicted Disturbance%	Cumulative Disturbance % Post Harvest[2]		
	34 40		Alt 3-WT/UB Alt 2a-WT/G					for harvest if post-harvest monitoring values exceed 15%.[3] Deep rip landing
31	5 5 Dropped	CT	Alt 2-S/G Alt 3-S/YT Alt 2a-Dropped	3	3/1/0	6/4/3		Unit Dropped
32	40	CC/RES	Alt 2-T/G Alt 3-T/G Alt 2a-WT/UB	5	10/10/4	15/15/9		Winter harvest.
33	20 20 27	CC/RES	Alt 2-S/G Alt 3-S/G Alt 2a-T/G	0	3/3/10	3/3/10		Restrict equipment to sustained slopes <40%,
34	98 98 68	CT	Alt 2-H/YT Alt 3-H/YT Alt 2a-TS/UB	0	0/0/8	0/0/8		Skyline slopes > 40%. Recontour temporary road and landings.
36	13 13 See 36a	ST/RES	Alt 2-S/G Alt 3-S/UB Alt 2a/See 36a	3	3/1/see 36a	6/4/see 36a		N/A
36a	8 8 21	ST/RES	Alt 2-T/G Alt 3-T/UB Alt 2a-T/UB	3	10/8/8	13/11/11		N/A
37	64 64 35	CT	Alt 2-T/UB Alt 3-T/UB Alt 2a-T/UB	0	8/8/8	8/8/8		N/A
40	17 0 17	ST/RES	Alt 2-T/G Alt 3-Dropped Alt 2a-T/UB	0	10/0/8	10/0/8		Restrict equipment to sustained slopes<40%, restricted operating season.
42	36 36 Dropped	CT	Alt 2-T/G Alt 3-T/YT Alt 2a-Dropped	5	10/8/0	15/13/0		N/A
43	63 63 18	CT	Alt 2-T/G Alt 3-T/YT Alt 2a-T/G	3	10/8/10	13/11/13		Restrict equipment to sustained slopes <40%.
44	18 18 18	ST/RES	Alt 2-S/YTJ Alt 3-S/YTJ Alt 2a-TS/YTJ	0	1/1/9	1/1/9		No adverse skidding. Skyline logs up to road.
45	10 10 32	CC/RES	Alt 2-T/G Alt 3-T/UB Alt 2a-T/UB	0	10/8/8	10/8/8		N/A
45a	20 20	CC/RES	Alt 2-S/YTJ Alt 3-S/YTJ	0	1/1/1	1/1/1		Skyline due to steep slopes

Unit #	Activity Area (acres)	Proposed Actions	Proposed Logging Systems and Fuels Treatment	Existing Detrimental Soil Disturbance (%)[1]	Action Alternatives 2/3/2a Potential Detrimental Soil Disturbance		Alt 2a Cumulative Disturbance Post Rehab[3]	Alt 2a Project Design Features To Protect Soils (Standard BMPs applied to all units)
					Predicted Disturbance%	Cumulative Disturbance % Post Harvest[2]		
	20		Alt 2aS/YTJ					
46	15 15 15	CC/RES	Alt 2-S/G Alt 3-S/G Alt 2a-S/UB	0	3/3/1	3/3/1		N/A
47	13 13 22	CT	Alt 2-S/YT Alt 3-S/YT Alt 2a-S/UB	0	1/1/1	1/1/1		Skyline due to steep slopes and sensitive soils
49	40 40 22	CC/RES	Alt 2-T/G Alt 3-S/YT Alt 2a-T/YT	3	10/1/8	13/4/11		N/A
50	86 20 52	CC/RES	Alt 2-S/G Alt 3-S/YT Alt 2a-T/YT	3	3/1/8	6/4/11		N/A
50a	0 20 0	ST	Alt 3-H/YT Alt 2a-S/YT	3	0/2	3/5		Skyline due to steep slopes. Recontour landings.
55	7 7 2	SALV	Alt 2-S/YT Alt 3-S/YT Alt 2a-T/YT	0	1/1/8	1/1/8		N/A
55a	11 11 1	SALV	Alt 2-S/YT Alt 3-S/YT Alt 2a-T/YT	0	1/1/8	1/1/8		N/A
55b	13 13 1	SALV	Alt 2-S/YT Alt 3-S/YT Alt 2a-T/YT	0	1/1/8	1/1/8		N/A
55c	17 17 1	SALV	All Alts-S/YT	0	1	1		N/A
55f	20 20 2	SALV	Alt 2-S/YT Alt 3-S/YT Alt 2a-T/YT	0	1/1/8	1/1/8		N/A
55g	39 39 1	SALV	All Alts-S/YT	0	1	1		Skyline/cable due to steep slopes
55h	Alt 2a-4	SALV	All Alts-S/YT	0	1	1		Skyline/cable due to steep slopes
55i	Alt 2a-5	SALV	All Alts-S/YT	0	1	1		Skyline/cable due to steep slopes
55j	Alt 2a-13	CT	Alts 2 & 3-S/YT Alt 2a-T/YT	0	1/1/8	1/1/8		Skyline/cable due to steep slopes
55k	Alt 2a-26	CC	All Alts-S/YT	0	1	1		Skyline/cable due to steep slopes
57& 57A	84	RE	Alt 2-H/YT Alt 3-H/YT	0	0	0		N/A

Unit #	Activity Area (acres)	Proposed Actions	Proposed Logging Systems and Fuels Treatment	Existing Detrimental Soil Disturbance (%)[1]	Action Alternatives 2/3/2a Potential Detrimental Soil Disturbance		Alt 2a Cumulative Disturbance Post Rehab[3]	Alt 2a Project Design Features To Protect Soils (Standard BMPs applied to all units)
					Predicted Disturbance%	Cumulative Disturbance % Post Harvest[2]		
			Alt 2a-Dropped					
60	40 40 40	ST/RES	Alt 2-T/G Alt 3-Dropped Alt 2a-T/G	3	8/0/8	11/0/8		N/A
61	0 21 21	Pile Fuels	Alt 2 – Dropped Alt 3 –Clip/G Alt 2a – Clip/G	3	0	3/3/3		N/A

CC/RES – Clearcut w. Reserves ST/RES – Seed Tree w. Reserves CT – Commercial Thin	SALV – Salvage RE – Release	H - Helicopter T – Tractor WT – Winter Tractor	S-Skyline UB – Underburn	G – Grapple Pile SG – Spot Grapple Pile YT – Yard Tops

[1]The Grizzly existing detrimental soil disturbance soil survey was conducted using the Howes (2000) protocol which is standard in Region 6. This method of soil disturbance classification is compatible with Region 1 soil monitoring guidelines when the R1 definition of detrimental disturbance is applied. However, the surveyors interpreted sample points with Class 3 disturbance (moderate disturbance) as "detrimental" without applying the Region 1 definition. Many Class 3 sample points would not meet the R1 definition of detrimental soil disturbance and, therefore, these pre-activity survey results report higher detrimental disturbance rates than would be found using the R1 definition. Thus, the figures in this column represent a conservative estimate.

[2]The cumulative disturbance assumes the project activity will be additive to the existing disturbance. However, some of the new disturbance would occur on the same locations as existing disturbance because existing temporary road, landing, and skid trail locations would be reused. As a result the actual cumulative disturbance is likely to be less than predicted in this column.

[3]The Forest Soil Scientist will conduct pre-harvest, post-harvest, and post-mitigation soil sampling Units 1, 2, 3, 18, and 20 using the R1 National Soil Disturbance Monitoring Protocol Rapid Assessments framework to monitor the change in soil compaction associated with harvest activities and related mitigation activities, and to ensure that the end values will be less than 15% soil compaction. If monitoring shows that post harvest values exceed 15%, skid trails would be rehabilitated and post rehabilitation monitoring conducted to ensure compliance with regional guidelines. The IDPF NF (R1) Moyie Place monitoring found reductions of 6% following skid trail decompaction activity located in past harvest units. (Rone 2007)

General Effects of Burning

The proposed burning would not impair long-term soil productivity. The ecosystem burn units B through F and the three wildfire burns G, H, and I on Grizzly Peak would lead to increases in mineral nutrients in short term for 1 to 2 years (Choromanska and Deluca 2002). MacKenzie et al. (2006) suggest that these fire effects may maintain higher nutrient availability in the long term.

Burning in the harvest units may have adverse effects from the combination of harvest and burn impacts (Prietikäinen and Fitze 1995), and the use of burning in primarily dry habitats such as Douglas-fir dominated stands. Burning where thick cedar ingrowth exists may have higher adverse effects. Field data from monitoring recently burned units with thick cedar and grand-fir ingrowth on the Clearwater NF showed a high level consumption of the coarse wood after burning and subsequent high levels of bare soil. Coarse wood was reduced from 60 to 80 tons/acre to 10 to 15 tons/acre in clearcut units with a high predominance of hemlock and cedar in growth. Recently cut and burned areas within the Grizzly project area showed similar coarse wood levels as the Clearwater with large reductions in duff and litter, but without the persistent bare soil. These effects are not anticipated to occur, as design features for this project would require yarding of tops to reduce activity fuels prior to burning, and burning would be restricted to periods of high soil moisture (greater than 25 percent).

Burn treatments of harvest slash would have less adverse effects by lowering the amount of consumption and not broadcast burning across the unit. Burning during higher fuel and soil moistures would lower consumption. These higher moistures present tradeoffs where soil microbial communities can be adversely affected from deeper heat penetration when burning in wet soils (Dunn et al. 1985, Hart et al. 2005), but may exclude the deep heating and organic matter losses associated with burning heavy fuels during dry times.

Coarse wood is beneficial for continued soil productivity by ameliorating the site after forest clearing. The wood provides microsites for microbial activity, retains carbon on site, and may moderate soil moisture (Graham et al. 1994, Brown et al. 2003). On wet sites such as the western redcedar forest types, Brown et al. (2003) recommend from 10 to 30 tons/acre of coarse wood be maintained after logging to balance soil productivity amelioration while addressing fuel hazard concerns. On the upper end, Graham et al. (1994) recommend from 15 to 30 tons/acre for similar western hemlock habitats. For dry sites, fuels and soils optimums range from 5 to 20 tons/acre (Brown et al. 2003), which is in agreement with ranges outlined by Graham et al. (1994) for Douglas-fir habitats.

Direct Effects of Fuels Treatments

Machine fuel treatments contrast between the action alternatives, and are displayed in Table 4 below. Detrimental impacts to soils are most likely to occur where fuels treatments are implemented with equipment. Although impacts from grapple piling can vary widely based upon implementation variables (soil moisture at time of operation, operator experience), other fuels treatments like yarding tops/lop and scatter, hand piling, and jackpot burning have either very low impact or beneficial effects to soil productivity with organic matter inputs. Monitoring on the Idaho Panhandle NF showed a drop from 30 percent detrimental disturbance from “hot” burns with heavy slash to 1 percent using cool conditions and moistures above 25 percent (Niehoff 2002). The effects of grapple piling, and fireline construction related to underburning in harvest units has been incorporated into the effects displayed in Table 3 above.

FEIS Appendix 2, Table 4. Machine Fuel Treatment Acres by Method for the Action Alternatives - replaces DEIS Table 25

Fuels Treatment	Alternative 2	Alternative 3	Alternative 2a
Grapple Piling/Burn Piles	692	203	248
Spot Grapple Piling/Burn Piles	20	45	60
Total	**712**	**248**	**308**

Underburning impacts where low-severity fire with intermittent unburned areas result, higher fuel complexity and greater preservation of forest duff/litter would ameliorate soils for increased moisture and retained nutrient base. Weed invasiveness would be less by limiting disturbance to the forest floor. Some higher severity fire impacts to soils may occur where high concentrations of slash are present. This would be primarily related to burning of piles resulting from grapple and hand piling. These piles are typically burned in late fall and winter, when soil moistures are high (greater than 25 percent), reducing potential impacts.

For the dry forest types, fire may complement mineral nutrient processes with short-term increases in mineral nitrogen (N) availability (Certini 2005, Hart et al. 2005). In addition, charcoal may lower the allelopathic effect of phenolic compounds associated with some conifer litter (Deluca et al. 2006). Working in unmanaged forests in western Montana, recent findings by MacKenzie et al. (2006) suggest that charcoal may continue to stimulate the mineralization of Nitrogen up to 50 years after a fire. Thus, the role of fire may be important for long-term soil productivity.

Road-related Impacts

The action alternatives have similar impacts to soils from roads. Alternative 2a contains 1.9 miles of improvement on existing temporary road templates and 0.8 miles of new temporary road miles for a total of 2.7 miles. Using a conversion factor of two acres of disturbance per mile of temporary road, about 5.4 acres of soils would be disturbed by temporary roads. Under all action alternatives, all temporary roads would be returned to contour, where soil hydrologic function would be impaired for the short term, as compared to natural forest levels, and improve over time as vegetation returns (Luce 1997, Foltz and Maillard 2004). Treatments of existing road templates would be considered to be trending towards improvement, meeting regional soils policy requirements. Implementation of BMPs reduces erosion associated with roads. The overall benefits of Alternative 2a would be similar to Alternatives 2 and 3 since the active decommissioning would have the greatest soil reclamation potential. Regarding road decommissioning, Alternative 2a includes 15.4 miles of active decommissioning and 27.4 miles of passive decommissioning for a total of approximately 43 miles of road decommissioning. At the same time 9.7 miles of Intermittent Stored Service (active) and 8.8 miles of Intermittent Stored Service (passive) for a total of 18.5 miles are called for under Alternative 2a. Such activities would include removal of culverts and natural contouring. Additionally, 65.5 miles of road would be designated open to motorized use while 38.8 miles would be designated as trails for non-motorized use. Approximately 8 miles of intermittent stored service and watershed restoration work would be completed prior to harvest activities (Gus and Pheasant Creeks, roads 902B and 903), with the remaining 22 miles being completed as funding is available. Best management practices would be implemented prior to harvest activities on roads 902, 6084C, 8021, and 8021B to address existing sediment sources."

The committed soils rehabilitation and best management practices work would have immediate effects towards improving soils conditions related to sediment production related to roads. As watershed rehabilitation (decommissioning) work is completed (as funding becomes available), additional improvement would be realized.

Cumulative Effects

The analysis of cumulative effects for Alternative 2a is the same as the analysis for Alternatives 2 and 3 found on pages 84 through 86 of the DEIS with the following exceptions:

Past Actions and their Effects on Current conditions: *(same as the first paragraph of this section on page 84 of the DEIS with the following exception:)* The specific modifications and design features are listed in FEIS Appendix 1.

Replace paragraph 2 with the following:

Field sampling (see soil surveys in project record) found approximately 158 acres of proposed harvest units (Units 1, 2, 3, 11, 12, 12a, 18, and 20) with existing higher soil disturbance values where cumulative impacts from the action alternatives combined with the existing conditions could impair long-term soil productivity. Existing detrimental disturbance on these units is from 6 to 13 percent. Roughly 548 acres have minor soil disturbance from mostly 1950s era select cutting (Units 4, 15, 17, 31, 32, 36, 36a, 42, 43, 49, 50, 50a). Existing detrimental disturbance on these units ranges from 1 to 5 percent. Past disturbance seemed limited to scattered harvest of bigger trees after the large fires in the early 1900s and white pine blister rust epidemic in the 1950s. The level of existing soil disturbance on these 548 acres is low enough that when combined with the anticipated impacts of the proposed activities, would remain below 15 percent detrimental soil disturbance. Proposed harvest activities for Alternative 2a combined with unit specific design features and post-harvest soil rehabilitation activities are anticipated to result in detrimental soil disturbance not exceeding 15%. Such activities include restricting harvest seasons, scarification of skid trails, pulling slash onto skid trails where harvest activities occurred during the Grizzly Project. It should be noted that treatment of all temporary roads and landings used for the proposed Grizzly harvest activities would be required regardless of whether soil concerns are present or not.

Contrasting Effects of Proposed Actions with Past Actions: *(same as found on page 85 of the DEIS)*

Combined Effects from Past, Present and Proposed Actions: *(the first paragraph is the same as the DEIS with the following exception:)*These effects are considered and are displayed in Table 3 of this FEIS appendix.

Replace paragraphs 2 – 4 with the following:

By minimizing additional disturbance, and treating existing and new disturbance with temporary roads and landings, the total detrimental disturbance in Units 1, 2, 3, 18, and 20 is not expected to exceed 15% after all activities are completed. The units would be logged following the same general skidding pattern as was used previously. This would insure that the new disturbance would not be completely additive. Winter logging would be used to reduce disturbance. On average, logging on frozen ground results in less than half the disturbance of logging during the normal summer season. These units were reviewed by the KNF Forest Soil Scientist, and upon consultation with district specialists familiar with area conditions, found winter logging operations feasible for these units. The units would be monitored post logging to determine what additional mitigation measures are necessary. These mitigations, such as scarifying skid trails, would be implemented after the fuels work is complete. Regardless of the results of the monitoring, existing temporary roads and landings associated with these units would be scarified, seeded, and covered with slash. Proposed harvest activities for Alternative 2a combined with unit specific design features are expected to result in detrimental soil disturbance not exceeding 15 percent.

Regulatory Consistency

The impacts to soils would meet regional guidelines for maintaining soil productivity with the incorporated design features. This assessment is based on field review of all the units by a qualified soil scientist with transect data collected where potential cumulative impacts had the potential to exceed regional thresholds of 15 percent (see soil surveys in project record). Based on field review, numerous modifications to the original proposed units were identified including: dropping units, reworking unit boundaries to lessen road building and skidding, and changing logging systems and fuels management. These modifications are discussed in Chapter 2, and are addressed in the cumulative effects section since much of the project has some impact from past activities. The modifications are project design features towards minimizing potential impacts to soils. No landslide risk was identified for the action alternatives.

Soil conservation practices as identified in the Soil and Water Conservation Handbook, State of Montana Best Management Practices code, and the timber sale contract would be applied (Appendix D). BMP monitoring by Kootenai NF personnel from 1990 to 2001 found high compliance with BMPs. Over this 12-year period, 97 percent of activities rated scored acceptable or better for implementation, and 94 percent of activities rated scored acceptable or better for effectiveness (USDA Forest Service 2002).

Forest Service Guidelines

Under all action alternatives the amount of cumulative detrimental disturbance would meet regional guidelines (USDA Forest Service 1999). Design features and unit modifications identified in FEIS Appendix 1 and Table 3 are specifically designed to minimize potential project disturbance to avoid long-term detrimental soil productivity. Monitoring by the Kootenai NF has shown that recent harvest units are consistently below the 15 percent cumulative detrimental disturbance (USDA Forest Service 2005). The silvicultural prescription, the timber sale contract, and the slash disposal contracts would include provisions to retain coarse woody material in the harvest units, which meet the guidelines recommended by Graham et al. (1994).

Forest Plan Consistency

Forest Plan standards are met with all alternatives by conducting this environmental analysis, designing logging systems to minimize disturbance, and implementing soil and water conservation practices through design and implementation.

Additional References

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