Soils and Erosion Processes Existing Conditions

Ecological Land Unit: The primary ecological land units used for the North Lochsa Face analysis are landtype associations (LTAs), landtypes, and landtype phases. These are small to mid-scale (1:10,000 to 1:100,000) classification units of the Nationwide Hierarchical Framework of Ecological Units (USDA 1993) adopted by the Forest Service in 1993. The national hierarchy includes 8 levels ranging from domains, which are broad scale ecological units useful at the international and national level to landtype phases, which are very small scale units useful for site-specific analysis.

Landtype Associations

LTAs, mapped at a 1:100,000 scale, were selected to describe landscape level vegetation patterns and historical disturbance regimes, primarily wildfire. LTAs are defined by general topographic landforms, surficial geology, geomorphic processes, soil characteristics, potential natural vegetation communities, and climatic conditions. These factors affect biotic distributions, hydrologic function, natural disturbance regimes, and other ecological processes at the landscape level.

Four major LTA groups are found within the North Lochsa Face analysis area: 1) stream breaklands, 2) colluvial midslopes, 3) frost-churned ridges, and 4) low relief rolling hills. In addition, two minor LTA groups, stream terraces and mass wasted sites are also present with the analysis area. See Chapter 3, Vegetation Existing Conditions, for additional information on the LTAs in the analysis area.

Stream breaklands are characterized by steep slopes (generally greater than 60%), adjacent to actively downcutting streams or rivers. This LTA group occupies 35.9% of the North Lochsa Face area. Mass wasting and other colluvial actions are the dominant erosional processes. These landforms are highly efficient at transporting sediment removed through erosional processes. The Mazama ash layer is frequently mixed, or even absent, on this LTA, due to past erosional events after wildfires. Consequently, ash presence on this LTA is indicative of erosionally stable areas since its deposition thousands of years ago. Fire is the major disturbance process here with typically frequent, mixed, lethal/nonlethal burns on south aspects and infrequent, lethal burns on north aspects.

Colluvial midslopes are transitional landforms with slopes ranging from 30 to 60%. This LTA group occupies 12.9% of the North Lochsa Face area. They often occur above stream breaklands and below gentler landforms at higher elevations. Ridges generally are convex and the sideslopes are straight. Soil creep, surface erosion, and mass wasting events are the dominant erosional processes. Fire disturbances are typically infrequent, mixed, lethal/nonlethal events.

Frost-churned ridges occur in upper slope, high elevation positions. This LTA group occupies 9.6% of the North Lochsa Face area. Slopes are generally less than 40%. Frost action and other physical weathering processes are the dominant types of erosion, resulting in mixed soils with high rock content. These areas usually occur above colluvial midslopes at the highest elevations within the analysis area. Fire occurs here as infrequent, lethal burns.

Low-relief, rolling hill LTAs form in areas of intense chemical and physical weathering processes. These areas have deep, productive soils usually with a thick (12”+) Mazama volcanic ash layer. This LTA group occupies 38.0% of the North Lochsa Face area. These landscapes are dominated by high-density drainage patterns with low vertical relief. Slopes are generally less than 30% so erosion is normally low on this LTA group. Fire occurs as very infrequent, lethal burns with intervals ranging from 151 to 300 years with periodic mixed lethal/nonlethal events occurring in smaller areas at more frequent intervals.

Mass wasted slopes are landforms that have previously experienced large landslides. This LTA occupies 1.6% of the North Lochsa Face area. They are generally found adjacent to breakland landforms, and have similar vegetation characteristics as well as erosional and fire disturbance patterns. For the purposes of this analysis, mass wasted LTAs, were combined with the breakland LTAs that have similar properties.

Stream Terraces are low-relief landforms occurring in depositional areas adjacent to streams, rivers, and glacial outwash plains. This LTA group occupies 2.2% of the North Lochsa Face analysis area. Slopes are generally low here, although steep channel banks are often present. Flooding with scouring and/or deposition are the dominant erosional processes

Table 60 shows the composition of LTA groups for the North Lochsa Face area:

Table 3-60: Landtype Association Composition for North Lochsa Face Analysis Area.

LTA	LTA Description	% of Area	LTA Groups	% Area
10A	Stream bottoms and meadows below 4500’	1.5%	Stream Terraces	2.2%
10B	Stream bottoms and meadows above 4500’	0.1%		
12A	Glacial terraces, alluvial fans, and outwash plains	0.4%		
14	Recent alluvial deposits	0.2%		
21A	South aspect, granitics breakland-thin soils	12.8%	Breaklands	35.9%
23A	South aspect, Border zone breakland-thin soils	4.0%		
21B	South aspect, granitics breakland-deep soils	8.2%		
23B	South aspect, Border zone breakland-deep soils	1.5%		
21C	North aspect, granitics breakland	7.7%		
23C	North aspect, Border zone breaklands	1.7%		
60	Belt series, colluvial midslopes	0.1%	Colluvial Midslopes	12.7%
61	Granitic, colluvial midslope	8.3%		
63	Border zone, colluvial midslope	4.3%		
71B	Granitic, frost churned ridges-dry	3.4%	Frost Churned	9.6%

LTA	LTA Description	% of Area	LTA Groups	% Area
71C	Granitic, frost churned ridges-moist/wet	6.2%	Ridges	
81A	Granitic, low relief hill-non-umbric	16.5%	Low Relief Hills	38.0%
81B	Granitic, low relief hill-umbric	17.6%		
83A	Alluvium, low relief hill	1.5%		
84A	Border Zone, low relief hill-non-umbric	2.4%		
90	Mass wasted areas	1.6%	Mass Wasted Areas	1.6%

Landtypes

In addition to LTAs, landtypes and landtype phases were analyzed to evaluate overall erosional characteristics with the analysis area and to assess site-specific erosion hazards associated with proposed management activities. Landtypes are ecological land units based on similarities in soils, landforms, geologic substrate, geomorphic processes, and plant associations (USDA 1993). Landtypes have been mapped for the entire Clearwater National Forest (Wilson et al. 1983) with watershed, engineering, silvicultural, and wildlife resource interpretations having been determined for each landtype. Landslide hazards, evaluated in terms of mass wasting and debris avalanche potentials, were determined for each landtype based on site characteristics and were calibrated (low, moderate, high, or very high hazard) based on actual landslide occurrence during 1974-1976 storm events.

The LTHAZ program was used to summarize erosional characteristics of the North Lochsa Face analysis area based on landtype properties. The following seven erosional characteristics were evaluated for the landtypes within the analysis area (Wilson et al. 1983):

1) Mass wasting potential evaluates the relative potential for mass soil movement caused by gravitational forces. It involves the movement of regolith as a coherent mass along a slippage plane created due to subsurface water concentration and other factors. Landtype properties used to evaluate this potential are: a) slope gradient, b) presence of concentrated subsurface groundwater (as determined by slope shape, whether water is concentrated or dispersed), c) substratum texture, d) regolith depth, and e) bedrock type.

2) Debris avalanche potential evaluates the probability of rapid and usually sudden downslope movement of initially consolidated debris. The slippage plane is often hard bedrock and debris avalanches often turn into mudflows as they move down slope and accumulate soil material. Landtype properties used to evaluate this potential are: a) slope gradient, b) slope shape, c) topsoil texture, and d) the occurrence of old slide scars and the accumulation of debris at the slope base.

3) Surface erosion potential considers raindrop splash and overland flow erosion on soils bared of vegetation, but which retain the root mat and soil structure. This potential is used for predicting surface erosion following prescribed or natural fires. Landtype properties used to evaluate this potential are: a) volcanic ash topsoil characteristics, b) slope gradient, c) depth to restricting layers, and d) slope shape. The presence of the Mazama volcanic ash cap plays an important role in surface

erosion potential since this material is extremely permeable, has a high water holding capacity, and thus is seldom associated with overland flow.

4) Subsurface erosion potential considers raindrop splash and overland flow where the subsoil has been exposed, or where the surface soil has been severely disturbed and mixed with the subsoil. This potential is used for predicting erosion occurring from shallow soil disturbance and displacement. Landtype properties used to evaluate this potential are: a) slope gradient, b) depth to restricting layers, and c) subsoil texture.

5) Parent material erosion potential considers raindrop splash and overland flow erosion that occur in deep excavations. Landtype properties used to evaluate this potential include parent material characteristics such as: a) extent of bedrock weathering , b) rock fragment content, and c) substratum permeability.

6) Sediment delivery efficiency is the ability of a landtype to deliver sediment produced from on-site sources to streams. The delivery efficiency rating reflects the delivery of naturally produced sediment on slopes as well as the acceleration of mass movement through management activities. Landtype properties used to evaluate this potential are: a) slope gradient, b) slope dissection, and c) slope shape.

7) Soil sensitivity class is a measure of the contrast in physical and chemical properties between surface and underlying subsoil horizons. Soils with major differences in such properties could be significantly damaged if the topsoil was removed or displaced.

The following table shows the relative hazards of each erosion type and their distribution across the North Lochsa Face analysis area:

Table 3-61: Landtype Erosional Characteristics for the North Lochsa Face Analysis Area.

Erosional Hazard Rating	Mass Wasting Potential	Debris Avalanche Potential	Surface Erosion Potential	Subsurface Erosion Potential	Parent Material Erosion Potential	Sediment Delivery Efficiency	Soil Sensitivity Class
Very High	8.0%	--	--	--	28.5%	27.3%	--
High	20.1%	17.0%	9.7%	30.0%	6.9%	25.2%	43.9%
Moderate	44.3%	21.4%	11.8%	42.7%	35.2%	28.6%	52.2%
Low	27.7%	61.6%	78.5%	27.3%	29.3%	19.0%	4.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The North Lochsa Face analysis area has a wide variety of landtypes reflecting a diversity of landforms, geology, soil types, dissection patterns, and other physical and biological properties that effect erosion processes.

The potential for mass wasting is low to moderate on 72.0% of the area and high, or very high, on 28.1% of the area. Potential for debris avalanches is low to moderate in 83.0% of the area, with 17.0% of the area having a high hazard. Surface erosion potential is low across much of the area (78.5%) due to the presence of the Mazama volcanic ashcap, which covers much of the area as a mixed or intact layer. Subsurface erosion and parent material erosion potentials are generally low to moderate with 70.0% and 64.5%, respectively, of the area having low or moderate hazards, 30.0%, and 35.4%, respectively, of the area having high or very high hazards. Sediment delivery efficiency is high to very high across 52.5% of the analysis area, due to the presence of steep landforms and well-developed dissections. The soil sensitivity is moderate to high with only 4.0% in the low category.

Landtype Phases

Landtype phases are the smallest ecological units recognized in the national ecological hierarchy (USDA 1993) typically mapped at a scale of 1:12,000 or less, with units commonly ranging from <10 to 100s of acres. They are based on topographic criteria (such as slope shape, steepness, aspect, position), hydrologic characteristics (including subsurface drainage, presence of springs, seeps, channels), soil properties, and plant associations and phases that that influence or reflect the microclimate and productivity of a site.

Landtype phases are used in the North Lochsa Face analysis area to identify site-specific erosion hazard zones within landtypes. A landtype such as 61G20 (south-aspect, dissected granitic breakland) is listed as having a high overall mass wasting hazard, but it is recognized that this landtype contains several (landtype phases, each with varying erosional hazards. A typical pattern on dissected breakland landtypes is concave dissections, or draws, alternating with rounded, secondary ridges running down the slope (Wilson et al. 1983). The concave dissection phase of this landtype presents a high risk of mass wasting since both surface and subsurface water flow is concentrated into these areas creating saturated conditions inferred to precipitate mass wasting events (McClelland et al. 1997). These concave dissections, sometimes referred to as colluvial hollows, may or may not contain perennial stream channels, or even the bed and bank characteristics of an intermittent, or ephemeral, stream. The convex, secondary ridge phase of this landtype presents a much lower hazard of mass wasting since both surface and subsurface water is dispersed from these areas. The generally straight slopes between the preceding phases have an intermediate hazard of mass wasting events, since water is neither concentrated nor dispersed.

Landtype phases are also identified based on additional site-specific features observed on the ground. For the North Lochsa Face project, landtype phases are identified primarily to recognize high mass wasting and debris avalanche potentials in proposed treatment areas. High landslide hazard areas are often indicated by wetland areas and moist seeps situated on slopes. Hydrophytic vegetation, indicating saturated soil conditions during at least a portion of the year, identifies areas where water is concentrated and may have high landslide hazards. Slopes in excess of 55% were identified by McClelland et al. (1997) as having an increased hazard for landslides. Past landslide locations may also may be high hazard areas for future slides.

The landtype phase thus allows the identification of varying erosional hazards within a larger landtype unit based on site-specific reviews. Due to the complexity of characteristics used to identify landtype phases and the enormous costs to complete such an effort, a map of landtype phase has not been developed for Clearwater National Forest. Instead, landtype maps, aerial photographs, vegetation maps, digital GIS layers, and other data sources are used as an initial screen to identify potential project areas. Based on this initial coarse screening process, potential treatment units are evaluated for erosional hazards. High hazard landtypes are examined to identify landtype phases with varying erosion hazards if a treatment need has been identified for that location. A diagrammatic representation of a typical landtype showing landtype phases and treatment mitigation features is shown in Figure 1 in Appendix A.

Landslide Hazards

During storm and flood events in the 1995-1996 period, over 860 landslides occurred across the Clearwater National Forest. A survey was conducted to review these landslides and five factors were identified to assess the inherent risk of landslides on the Clearwater National Forest (McClelland et al. 1997). Their analysis was based upon an inventory of landslides that occurred on the Forest during storm events in the fall of 1995 and the winter/spring period of 1996. The information reported by McClelland was modified, based on corrections made to the landslide database (Clearwater National Forest 2000). The five factors, which confirmed previous findings by Day and Megahan (1977), are:

1. **Geologic Parent Material:** Landslide frequencies, in decreasing order, by geologic parent material, were: Border Zone metamorphics (1.06 slides/1000acres), Belt Series metasediments (0.56 slides/1000 acres), Idaho Batholith granitics (0.28 slides/1000 acres), volcanics (0.16 slides/1000 acres), sediments (0.16 slides/1000 acres), and no slides on other the other geologic parent materials which comprise a minor amount of the Forest. The overall landslide rate across all geologic types was 0.50 slides/1000 acres.
2. **Elevation**: The elevation zones with the highest rate of landslides were: 3001-3500’(1.66 slides/1000 acres), less than 2000’ (1.65 slides/1000 acres), 2501’-3000’ (1.48 slides/1000 acres), 3501’-4000’ (1.10 slides/1000 acres), 2001’-2500’ (0.90 slides/1000acres), 4001’-4500’ (0.85 slides/1000 acres), and 4501’-5000’ (0.50 slides/1000 acres). There were very few slides occurred above 5000’ in elevation.
3. **Aspect:** The aspects with the most landslides were: south (21.8% of the slides), southwest (20.8%), west (16.8%), and southeast (14.9%). There were relatively few landslides on northwest, north, and northeast aspects.
4. **Slope Angle:** The highest rate of landslides occurred on slopes in excess of 56% (2.00 slides/1000 acres), followed by 46-50% slopes (0.73 slides/1000 acres), 51-55% slopes (0.59 slides/1000 acres), and 41-45% slopes (0.43 slides/1000 acres). Few slides occurred on slopes less than 35%.
5. **Landform**: The greatest landslide rate occurred on mass wasted slopes (1.72 slides/1000 acres), followed by breaklands (1.12 slides/1000 acres), stream

terraces/valley bottoms (0.70 slides/1000 acres), and colluvial midslopes (0.54 slides/1000 acres). Few landslides occurred on low-relief hills and frost-churned ridges.

Geology, slope angle, and landform are often considered to be the most important factors since elevation and aspect generally impact climatic conditions (whether the precipitation occurred as rain or snow) and the storm direction.

The geologic parent material of the North Lochsa Face analysis area is comprised primarily of Idaho Batholith granitics rocks (80.8%), Border Zone metasedimentary rocks (18.5%), and smaller inclusions of sedimentary rocks. The landslide hazard associated with granitics rocks, which dominate the analysis area, was considered moderate, compared to Border Zone metamorphic rocks and Belt Series metasedimentary rocks.

Elevations within the North Lochsa Face analysis area range from less than 2000' along the Lochsa River to over 6000' at Rocky Ridge. This range coincides with the zone where the majority of landslides occurred during the 1995-1996 storm events.

Aspect varies considerably throughout the analysis area. South-aspect breaklands comprise 26.5% of the area while north aspect breaklands account for 9.4%. Landslide frequency during the 1995-1996 storm events was greatest on southeast to west aspects.

Like aspect, slope angle varies considerably in the North Lochsa Face analysis area. Slope angle, is also closely associated with landform (LTA groups), since certain landforms typically have steeper slopes than others. As shown in Table 3-60, low-relief hills (38.0%) and breakland (35.9%) LTAs dominate the analysis area while colluvial midslope (12.7%) and frost-churned ridges (9.6%) are the next most common LTAs. Low-relief hills generally have slope angles less than 30%, while breakland usually have slopes over 60%; therefore, landslide hazard is greater on the breaklands than the low-relief hills. Colluvial midslopes (30-60% average slope angle) and frost-churned ridges (average slope angle is less than 40%) have intermediate hazards.

The dramatic North Lochsa Face area that exists today is the product of ongoing erosion processes operating as the Lochsa River and other streams continue downcutting into the underlying geologic substrate. Overlying much of the area is a mixed to continuous layer of volcanic ash deposited approximately 6700 years ago when Mount Mazama erupted in what is now southwestern Oregon (Powers and Wilcox 1964). This material has a silt loam texture (Sexton 1986; Johnson-Maynard 1997), high water-holding capacity and low bulk density (Daniels and Hammer 1992), and high phosphate retention (Baham and Simonson 1985). Site quality is generally associated with increasing ash thickness and it presents a means to predict surface erosion potential (Sexton 1986) because areas that retain thick ash caps have resisted erosive forces for over 6700 years.

Mass wasting and other erosion events still occur and will continue to shape this landscape in the future. During high precipitation storm events in 1995 and 1996, 93 landslides were observed (Clearwater NF 2000) in the North Lochsa Face area, at a rate of 0.73

landslides/1000 acres. The locations of these landslides by site origin (61 landslides from system roads, 8 landslides from jammer roads, 15 landslides in harvest units (14 landslides in complete canopy removal areas, and 1 landslide in a partial canopy removal harvest), and 9 naturally occurring landslides) are shown in Table 3-62. The landslide rate in complete canopy removal harvest areas was 1.16 landslides/1000 acres while the rate in partially harvested areas was 0.21 landslides/1000 acres. The rate for naturally occurring landslides was 0.08 landslides/1000 acres. This map also shows major drainages and watersheds within the analysis area. The following tables further summarize the characteristics of the 1995-1996 landslide events by geology, LTAs, landtype, and watershed.

Table 3-62: Landslide Distribution in North Lochsa Face Area after 1995-1996 Storm Events by Geology and Landslide Source Area.

Geology	Landslide Source Area					Totals
	System Roads	Jammer Roads	Harvest-Complete	Harvest-Partial	Natural	
Border Zone	35	7	5	1	5	53 (57.0%)
Idaho Batholith	26	1	9	0	4	40 (43.0%)
Totals	61 (65.6%)	8 (8.6%)	14 (15.1%)	1 (1.1%)	9 (9.7%)	93 (100.0%)

The majority (74.2%) of slides occurred from roads (primarily system roads), with 60.9% of those slides on Border Zone rock types. Slides in harvest units occurred more frequently on Idaho Batholith granitics (60.0%) while natural slides were fairly evenly split between the two rock types. It is apparent from the landslide frequency information that Border Zone rocks are more susceptible to landslides. The Border Zone materials comprise only 18.5% of the analysis area, yet 57.0% of the landslides occurred on this rock type. Only 43.0% of the landslides occurred on Idaho Batholith granitics, which comprise 80.8% of the analysis area.

Table 3-63: Landslide Distribution in North Lochsa Face Area after 1995-1996 Storm Events by LTA and Landslide Source Area

LTA	Landslide Source					Totals
	System Roads	Jammer Road	Harvest-Complete	Harvest-Partial	Natural	
10A	3	0	0	0	0	**3 (3.2%)**
21A	9	0	4	0	4	**17 (18.3%)**
23A	0	1	0	0	2	**3 (3.2%)**
21B	0	0	1	0	0	**1 (1.1%)**
23B	3	0	0	1	2	**6 (6.5%)**
61	8	0	2	0	0	**10 (10.8%)**
63	21	7	3	0	0	**31 (33.3%)**
81A	9	0	4	0	0	**13 (14.0%)**
81B	3	0	0	0	0	**3 (3.2%)**
83A	4	0	0	0	0	**4 (4.3%)**

LTA	Landslide Source					Totals
	System Roads	Jammer Road	Harvest-Complete	Harvest-Partial	Natural	
84A	1	0	0	0	1	**2 (2.2%)**
Totals	**61 (65.6%)**	**8 (8.6%0)**	**14 (15.1%)**	**1 (1.1%)**	**9 (9.7%)**	**93 (100.0%)**

The highest frequency of landslides occurred on colluvial midslope LTAs (61 and 63) with 44.1% of the total number of landslides occurring there. Breakland LTAs (21A, 21B, 23A, and 23B) accounted for the next highest frequency with 29.1%. Low-relief hill LTAs (81A, 81B, 83A, and 84A) had 23.7% of the total number of slides. The vast majority (87.8%) of the landslides on colluvial midslope LTAs were road related, while less than half (48.1%) of the breakland landslides were road related. This is likely due to the higher concentration of roads on the gentler colluvial midslope LTAs. Similarly, 86.4% of the landslides occurring on low-relief hill LTAs were road related. Naturally occurring slides were most common on breakland LTAs (88.9%).

Table 3-64: Landslide Distribution in North Lochsa Face Area after 1995-1996 Storm Events by Landtypes and Landslide Source Area.

Landtype	Landslide Source					Totals
	System Roads	Jammer Road	Harvest-Complete	Harvest-Partial	Natural	
10A40	3	0	0	0	0	**3 (3.2%)**
22A01	1	0	0	0	0	**1 (1.1%)**
22K00	2	0	0	0	0	**2 (2.2%)**
22K45	2	0	0	0	0	**2 (2.2%)**
24A01	3	0	0	0	0	**3 (3.2%)**
24K10	3	0	0	0	0	**3 (3.2%)**
24K20	4	0	1	0	0	**5 (5.4%)**
24S10	1	0	0	0	1	**2 (2.2%)**
31G20	0	0	1	0	0	**1 (1.1%)**
31K20	2	0	3	0	0	**5 (5.4%)**
31S10	5	0	1	0	0	**6 (6.5%)**
31S20	15	4	2	0	0	**21 (22.6%)**
31S45	2	1	0	0	0	**3 (3.2%)**
50	0	0	0	0	1	**1 (1.1%)**
60U26	2	0	0	0	0	**2 (2.2%)**
61S10	3	0	1	1	2	**7 (7.5%)**
61S20	7	3	0	0	0	**10 (10.8%)**
61S26	2	0	0	0	2	**4 (4.3%)**
61U26	3	0	1	0	0	**4 (4.3%)**
61U30	1	0	0	0	1	**2 (2.2%)**
61U31	0	0	4	0	2	**6 (6.5%)**
Totals	**61 (65.6%)**	**8 (8.6%0)**	**14 (15.1%)**	**1 (1.1%)**	**9 (9.7%)**	**93 (100.0%)**

Landslide occurrence varied greatly among the different landtype present in the North Lochsa Face analysis area. Landtype 31S20 had the greatest number of landslides (21) while landtype 61S20 had the next highest (10).

Table 3-65: Landslide Distribution in North Lochsa Face Area after 1995-1996 Storm Events by Watersheds and Landslide Source Area

Watershed	Road Density (miles/mi^2)	Landslide Source					Total Landslides	Landslide Density (#/1000 ac)
		System Roads	Jammer Road	Harvest-Complete	Harvest-Partial	Natural		
Pete King	**4.49**	**29**	**7**	**2**	**1**	**4**	**43**	**2.44**
WF Pete King	6.83	7	4	2	0	0	13	2.72
Polar	4.70	3	0	0	1	1	5	3.14
Walde	6.98	13	3	0	0	0	16	4.31
Lower Pete King	1.66	6	0	0	0	2	8	1.77
Placer	2.47	0	0	0	0	0	0	0.00
Nut	1.31	0	0	0	0	1	1	0.66
Rye Patch	**2.04**	**0**	**1**	**0**	**0**	**1**	**2**	**1.36**
Canyon	**4.85**	**18**	**0**	**5**	**0**	**0**	**23**	**1.83**
Mystery	6.26	0	0	0	0	0	0	0.00
Upper Canyon	7.25	12	0	2	0	0	14	3.47
Lower Canyon	2.38	0	0	0	0	0	0	0.00
South Fork Canyon	3.98	3	0	0	0	0	3	1.05
Apgar	**0.73**	**1**	**0**	**0**	**0**	**0**	**1**	**0.95**
Glade	**3.91**	**1**	**0**	**1**	**0**	**0**	**2**	**0.63**
Deadman	**1.64**	**3**	**0**	**5**	**0**	**0**	**8**	**0.63**
EF Deadman	1.73	0	0	0	0	0	0	0.00
WF Deadman	3.11	1	0	5	0	0	6	1.42
MF Deadman	0.91	0	0	0	0	0	0	0.00
Lower Deadman	0.00	2	0	0	0	0	2	1.51
Bimerick	**0.55**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Fish (above Hungery)	**0.52**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Frenchman	1.36	0	0	0	0	0	0	0.00
Hungery	0.33	0	0	0	0	0	0	0.00
Willow	0.00	0	0	0	0	0	0	0.00
Fish (below Hungery)	**0.21**	**0**	**0**	**0**	**0**	**1**	**1**	**0.23**
Face Drainages	**0.39**	**6**	**0**	**1**	**0**	**3**	**10**	**0.62**
Face Bee-Sardine	0.00	0	0	0	0	0	0	0.00
Face Otter Slide	0.00	0	0	0	0	1	1	0.54
Face Westside Black Canyon	0.00	0	0	0	0	2	2	0.31
Face Tick	0.00	3	0	0	0	0	3	1.52
Face Unnamed #1	0.00	0	0	0	0	0	0	0.00
Face Unnamed #2	0.00	0	0	0	0	0	0	0.00

Watershed	Road Density (miles/mi^2)	Landslide Source					Total Landslides	Landslide Density (#/1000 ac)
		System Roads	Jammer Road	Harvest-Complete	Harvest-Partial	Natural		
Face Unnamed #3	0.00	0	0	0	0	0	0	0.00
Face Unnamed #4	0.00	0	0	0	0	0	0	0.00
Face Unnamed #5	0.00	0	0	0	0	0	0	0.00
Face Unnamed #6	3.82	3	0	1	0	0	4	2.45
Totals		**61 (65.6%)**	**8 (8.6%0)**	**14 (15.1%)**	**1 (1.1%)**	**9 (9.7%)**	**93 (100%)**	**0.73**

The Walde Creek watershed in the Pete King drainage had the highest landslide density (4.31 landslides/1000 acres) followed by the Upper Canyon Creek watershed (3.47 landslides/1000 acres). Not surprisingly, these watersheds also have the highest road densities in the North Lochsa Face analysis area at 6.98 miles/mile^2 and 7.25 miles/mile^2, respectively.

Because of the high rates of road related landslides in many of the North Lochsa Face watersheds, it became obvious that if old unneeded roads remained on the slopes, the potential existed for more failures and further degradation of aquatic habitat. In recognition of this risk, the Forest embarked on an aggressive road obliteration program. Further discussion of road obliteration efforts is included in the watershed portion of this chapter.

Soils and Erosion Processes Environmental Consequences

Landscape Setting and Management Emphasis: The following discussion analyzes the environmental consequences of the project alternatives on the soil resource and erosional processes. The North Lochsa Face project emphasizes a multiple-use approach utilizing the concepts of ecosystem management to develop treatment alternatives that recognize natural landscape patterns and processes. The utilization of such an approach is a significant departure from traditional management philosophies focusing on only one or two resources. The identification of treatment areas was determined using a landscape level perspective that analyzed historical conditions and processes across the entire project area. Historical fire regimes, ecological successional stage distributions, vegetative species composition and structure, inherent site erosional hazards, wildlife distribution and habitat patterns, aquatic conditions and processes, and a variety of other factors were analyzed to determine treatment needs from a landscape perspective. By understanding the natural processes that have been operating across the landscape for thousands of years, reference conditions have been established as baselines for assessing both the extent and the effects of proposed management activities on various resources.

Due to the unique emphasis of the North Lochsa Face project, focusing on ecosystem management, the following discussions focus on: the erosional hazards present in the area,

the relationship between fire history and erosional processes, project design and mitigation, silvicultural treatments, unit reviews for soil concerns, evaluation of the no-action alternative, evaluation of the action alternatives, and cumulative effects.

Erosion Hazards

It is important to define which erosion hazard, or hazards, are being evaluated, when discussing the impacts of alternatives on soils and erosional processes. Landslides, debris torrents, surface erosion, and other erosional events have occurred periodically (McClelland et al. 1997) for thousands of years across this landscape as evidenced by the steep topography that exists today. Erosional mass wasting events are most frequent during periodic storms and associated flooding. "Rain on snow" events are particularly common precursors to landslides and other erosional events as recently experienced throughout the Clearwater Basin in 1995-96 (McClelland et al.1997), as well as previous years.

For the North Lochsa Face analysis area, mass wasting hazard, debris avalanche potential, surface erosion potential, subsurface erosion potential, parent material erosion potential, sediment delivery efficiency, and soil sensitivity class were evaluated across the area based on landtype characteristics using the LTHAZ program. Landtype hazards were developed by Wilson and others (1983) through an analysis of soil, slope, geologic, drainage, and vegetation characteristics. This evaluation of landtypes showed a variety of erosion hazards throughout the area. Surface erosion and debris avalanche hazards are generally low across most of the analysis area (78.5% and 61.6%, respectively), while sediment delivery efficiency was high to very high across 52.5% of the area. Concurrent analysis of vegetative conditions on certain LTAs showed major departures from historical conditions due to past wildfires, fire suppression, disease and insect activities, and other factors, suggesting treatment needs to return vegetation conditions within historical ranges of variability.

Landtype erosion potential encompasses many factors including: slope shape, geologic parent materials, slope gradient, slope aspect, climatic conditions, vegetative cover, soil texture and thickness, fire history, and management activities. All these factors were considered in the assessment of erosion hazards related to the North Lochsa Face project utilizing aerial photos, maps, and site visits.

Fire History and Erosional Processes

Fire has been recognized as an important natural factor for creating, maintaining, and replacing vegetative communities across the landscape. Historically, major erosional events have often been associated with the periodic fires across the Clearwater National Forest. Photo interpretation of 1934 aerial photos in the Salmon Creek drainage in the North Fork Clearwater River basin (approximately 30 miles from the North Lochsa Face analysis area) showed at least 77 landslides, over 10 miles of debris torrents, and other erosional events in unroaded areas resulting from a wildfire in 1933. Wildfires and subsequent storm events can cause a considerable loss of soil, significantly reducing site productivity. This is particularly significant in areas with Mazama volcanic ash surface soil layers.

Under ecosystem management principles, the importance of restoring and maintaining natural fire cycles (and the resultant vegetation communities) is an important objective, but the development of management activities (including management ignited fire) to restore these fire cycles and plant communities must be conducted so that erosional events are not accelerated beyond natural ranges. It must also be recognized that ecosystems are not static and natural processes will continue to operate whether or not any management activities are conducted. In the absence of management activities, fire will continue to be the major disturbance process across the analysis area and erosional events will occur as well.

Project Design and Erosion Mitigation Measures

Landslides, debris flows, surface erosion, and other colluvial movements of soil, wood, and geologic parent materials are natural processes that have occurred coincidentally with wildfire for thousands of years, creating the North Lochsa Face landscape as it is today. Erosional events resulting from climatic conditions, similar to the storm events that occurred in 1995-1996, are periodic natural processes that have contributed to the formation of the existing landforms. These past erosional events have historically followed natural wildfires that burned during hot, dry periods in the summer and/or fall. The activities associated with the action alternatives in the North Lochsa Face project have been designed to reduce stand densities and fuel loadings within the historical range of variability, effectively lowering the risk of large-scale erosional events associated with catastrophic wildfires in the future. Historically, the typical low to moderate intensity fire effectively maintained fuel loadings within a predictable range. Consequently, erosional events generally were not extreme when they occurred, although there were exceptions. Current vegetative conditions are outside the historical range of variability on some LTAs, particularly breaklands, due to past fire suppression and other factors. If existing stand densities and fuel levels are allowed to continue increasing, there is an increasing likelihood of large stand-replacing fire rather than low to moderate intensity, mixed lethal/non-lethal fires occurring in the North Lochsa Face analysis area.

Surface erosion is most affected by the thickness of the litter layer, and the distribution of fine roots in the upper soil horizons, while mass wasting potential is more affected by the distribution of large tree roots in the entire rooting zone. The root mat includes shrub, forb, and graminoid roots, as well as tree roots, that generally are present after a disturbance. The fine root mat is generally retained (or becomes quickly reestablished) after timber harvest or stand-replacement fires. Even after complete clearcuts followed by low intensity prescribed burns, tree root strength remains relatively high for up to five years after the trees are removed (Burroughs and Thomas, 1977; Ziemer and Swanston 1977). At that time, the decomposition rate of roots accelerates and the organic material rapidly starts breaking down, resulting in a loss of soil anchoring strength. Soil root strength gradually increases as a new stand develops and tree roots fully occupy the site.

Rresearch summarized in the Scientific Assessment for the Interior Columbia Basin Ecosystem Management Project (Quigley et. al. 1997) has shown streamside buffers to be adequate for filtering surface sediment from reaching streams. This assessment concluded (based on several studies conducted in Idaho and elsewhere) that 300-foot buffer widths are

generally effective for controlling sediment that is not channelized. This statement was primarily based on conclusions in Belt et. al. (1992) report which noted (based on the above referenced studies) that sediment rarely travels more than about 300 feet for non-channelized flows. Forest monitoring has confirmed these findings (USDA Forest Service 1997, 1998, 1999a 2000a, 2000b). Quigley et. al. (1997) noted that a review of the literature also supports the conclusion that the INFISH riparian buffers provide adequate protection for other riparian functions. These include the shade along streams for maintenance of summer stream temperatures, woody debris recruitment, nutrient input and stream bank stability.

It is unusual to completely lose the root mat after harvesting as the shrub, forb, and graminoid components usually re-sprout to varying extents. However, tree roots account for much of the soil anchoring ability, and soil stability increases when a new stand becomes established on a previously harvested site. It has been well documented that retention of tree canopy cover on steep terrain is effective in reducing landslide hazard as the vast majority of landslides occur in areas harvested using clearcut methods (Swanson and Dryness 1975, Swanston and Swanson 1976; Swanson and Lienkaemper 1978; Gresswell et al. 1979; Wu and Swanston 1980). During the 1995-1996 flood events, 15 landslides occurred in previous harvest units within the analysis area, with 14 occurring in clearcuts. Due to the past predominance of the clearcut harvest method throughout the Northwest, the minimal level of canopy retention to maintain slope stability has not been well documented. However, computer simulations run using the Level I Stability Analysis (LISA) model (Hammond et al. 1992) showed that increasing canopy retention reduced erosional hazards.

Due to the erosional hazards associated with harvest practices removing all or most of the tree canopy on high-risk landtype phases, the proposed activities in the action alternatives for the North Lochsa Face project have been designed with slope stability considerations as a primary objective. The planned treatments for the North Lochsa Face project vary by LTA, ranging from steep, breakland landforms where an average live canopy cover of at least 50% would be retained across the slope, to low-relief, rolling hill LTAs ("old surfaces") where an average of 25% live canopy cover would be retained across the landscape.

The proposed activities for the action alternatives in the North Lochsa Face project were developed recognizing natural fire disturbance regimes and patterns. For example, natural fire processes acting on steep breakland LTAs would typically retain live tree canopies of approximately 50% across the slope after a low to moderate intensity fire, which is the usual disturbance event on these landforms. The typical live canopy retention on breakland landtypes after a natural fire is inferred to have been distributed as follows (landtype phases) in the North Lochsa Face area (and is shown graphically in Appendix A, Figure 1):

- **Riparian areas and concave dissections**: Fire burned with low intensity due to moist, humid conditions. Post-burn, live canopy cover averaged 70-100%.
- **Well-drained, secondary, convex (rounded) ridges running down the slope:** Fire burned more intensely due to drier conditions. Average post-burn, live canopy retention ranged from 0-30%. Large, individual trees or clumps of larger trees may have survived the burn, but most of the small trees would be killed.

✍✍**Areas between the two preceding zones (predominantly straight slopes):** Fire would burn a variable amount of the canopy, depending on tree species, tree size, fuel conditions, wind directions, etc. An intermediate amount of live canopy cover (30-70%) would typically remain after a wildfire.

Overall, an average of 50% live canopy cover would remain across the entire breakland slope (disturbance patch) after a typical historic fire. Actual canopy cover would vary from near 0% (on portions of well-drained ridges) to 100% (in riparian areas and concave dissections) within the three preceding phases in a breakland landtype.

Landslide hazard within breakland landtypes varies coincidentally with historic fire patterns. The hazard is highest in riparian areas and concave dissections (sometimes referred to as colluvial hollows) where moisture levels are the highest due to the concentration of surface and subsurface water flows and lowest on well-drained, convex, secondary ridges where water flow is dispersed. Landslide hazard is intermediate in the generally straight slopes between the two preceding areas. In riparian areas where the hazard is the greatest, live canopy retention would be 100%, as PACFISH buffers would be applied to protect this critical interface between terrestrial and aquatic ecosystems. PACFISH buffer widths are: 300' around perennial fish-bearing streams, 150' around perennial, nonfish-bearing streams, and 100' around intermittent streams. Live canopy cover would average 50% on intermediate, straight slopes; and retention of at least 15% canopy cover would occur on well-drained, convex, secondary ridges where the landslide hazard is the lowest.

Please see Appendix A, Diagram 1, for a visual representation of estimated live canopy retention after low to moderate intensity wildfire on breaklands landtype.

Silvicultural Treatments

The application of Best Management Practices (BMPs) is the main preventative measure used to control surface erosion and subsequent delivery of sediment to streams during management activities (including timber harvest, road construction and maintenance, fuels management projects, and other types of activities). The Idaho Forest Practices Act (Idaho Department of Lands 2000) and the Forest Service, Region 1 Soil and Water conservation Practices Handbook (USDA Forest Service 1988) provide direction for the required implementation methods of the BMPs used on the Clearwater NF. Implementation and effectiveness of BMPs used in treatment areas on the Clearwater NF has consistently averaged 97 to 99% (USDA Forest Service 1994, USDA Forest Service 1997, USDA Forest Service 1998, USDA Forest Service 1999, USDA Forest Service 1999, USDA Forest Service 2000), so it is extremely unlikely that surface erosion from treatment areas will occur. Consequently, it is unlikely that any surface erosion generated sediment will reach streams from proposed activities in the North Lochsa Face area. Further details of BMPs to minimize surface erosion in treatment areas are presented in Jones (2001).

To minimize the risk of landslides and other mass movements on breakland LTAs, the silvicultural harvest treatments proposed for the North Lochsa Face project have been designed recognizing natural fire patterns, thereby avoiding the corresponding high landslide

hazard areas. All riparian areas will have no harvest (and no prescribed fire ignition points) PACFISH buffers (100% live canopy retention) ranging from 100' to 300' in width. In addition, wetlands and previous landslide locations will have 100' buffers. Non-riparian, concave dissections would include up to full canopy retention based on site-specific hazard assessments made in the field by resource specialists. These landtype positions have the highest risk of mass wasting. Silvicultural treatments including salvage harvest, seed tree, and shelterwood harvests (15% minimum live canopy retention) are proposed on well-drained, convex, secondary ridges landtype positions where the hazard of landslides is lowest. Methods including thinnings, shelterwood, individual and group selection operations (50% minimum live canopy retention) are proposed in intermediate, straight slopes landtype positions where landslide hazards are moderate. Diameters of openings in this portion of a landtype will be limited to no more than twice the average canopy height to maintain slope stability.

Similar prescription patterns will be used on gentler LTAs, with overall live canopy retention being at least 35% on colluvial midslope and frost churned ridge LTAs, and at least 25% live canopy retention on low-relief, rolling hill and glaciated upland LTAs. In all areas, regardless of LTA, high landslide risk inclusions would either be avoided altogether, or appropriate mitigation measures would be applied. These areas include, but are not limited to: moist seeps and wetland areas (indicated by the presence of hydrophytic vegetation such as sedges, lady ferns, sword fern, *Boykina*, etc.); steep slopes (60+%), concave slopes and dissections (horizontally and vertically) which accumulate water; past landslide locations; and areas of obvious soil movement indicated by curved and/or buttressed tree boles, soil creep, tension cracks, etc.

The same prescriptive treatments will apply to prescribed burn treatment units. Fire will not be ignited in riparian areas, concave dissections, wet seeps, or other high landslide portions within a landtype. In lower landslide hazard portions of landtypes, ignitions will only be made after a major rainfall event has increased to duff/litter moisture content to approximately 100% to ensure the prescribed fire will burn with a low to moderate intensity.

Unit Reviews for Stability Concerns

Site-specific identification and evaluation of high landslide hazard terrain is integral in governing unit layout. Hazard analysis is conducted based on analysis of landtype maps, aerial photos, and field reviews. The evaluation of high hazard landtypes is the first stage, but it is important to recognize that there are high hazard inclusions (phases) in low hazard landtypes, as well as low risk inclusions (phases) in high hazard landtypes. Because of this situation, the Forest Soil Scientist will be directly involved in project field reviews and unit layout along with other resource specialists including wildlife biologists, hydrologists, fire specialists, silviculturists, and fish biologists to ensure that high erosional risk areas are protected. Modifications will be made in both treatment area boundaries and silvicultural methods, based on avoiding high landslide hazard phases identified during these field reviews. Detailed hazard analysis and application of mitigation measures for the action alternatives are designed to maintain landslide hazards within or below historical levels. The recognition of natural fire patterns and associated historic high landslide hazard phases has

been an integral part of treatment area design in the North Lochsa Face project. Treatments in areas proposed for management ignited fire would be undertaken only when conditions are conducive for low to moderate intensity burns. Although burn area boundaries cannot be as easily defined in actual on-the-ground layout, fire will be ignited such that it can follow historic patterns and perform the critical ecosystem processes that have operated across the landscape for thousands of years. Landslides and other erosional processes associated with these burn activities should be within historical levels, since ignitions will only be made when duff/litter moisture levels are high.

The North Lochsa Face proposal follows natural fire patterns in the action alternatives and represents a sustainable model to restore the natural vegetation composition, structure, and function on these sites. The following describes the effects of each alternative, if implemented:

Alternative 1 (No Action): If proposed activities associated with the North Lochsa Face project are not undertaken, it is likely that extremely high intensity natural wildfires may occur across parts of the analysis area, particularly steep, breakland LTA locations. These areas have been most impacted by fire suppression over the past 60 years, which has resulted in increased amounts of downed woody materials above historical levels. Two or more fires have been missed on LTAs with 25-50 year fire return intervals, due to fire suppression, so ladder fuels and tree densities are much higher than historical ranges. If a fire occurred in these locations, there is a high probability that it would burn with a greater than normal intensity and would likely create hydrophobic soil conditions across much of the area. Hydrophobic conditions restrict water infiltration into the soil, resulting in increased erosional events. In addition, the entire duff/litter layer, as well as organic matter within the mineral soil itself, is often consumed by high intensity wildfires. The erosional, mass wasting, and sedimentation risks of such an event may exceed the average historical intensities.

The scope of high intensity wildfires may occur over larger areas than historical patch sizes due to past fire suppression creating uniform vegetation patterns and fuel loadings across the landscape. Past catastrophic wildfire events, most notably the 1910 fires, and the 1919 and 1934 fires to a lesser extent, have caused significant erosional impacts throughout the Clearwater basin. Pyne (1997) reported that after the 1910 wildfires in northern Idaho and western Montana, "(s)heet erosion became severe in places, and some rivers, like the St. Regis, showed unstable behavior for many years afterward." Arno (1980) reports that in forest stands in the western redcedar habitat type series, early century wildfires were "associated with strong winds and extremely dry conditions. In several cases, the dead fallen timber created by one fire predisposed the area to one or more successive burns within 25 years or less." It has been well documented that erosion commonly occurs in forested ecosystems after wildfires (Sartz 1953; Krammes 1960; Debano 1968; Wells and White 1978; Benda et al. 1998; Anderson 1999). It is clear that much research literature indicates that intense wildfires can cause significant increases in erosion in forest ecosystems whenever they occur, even in the absence of management activities.

All Action Alternatives: The proposed activities associated with the action alternatives in

the North Lochsa Face project are designed to restore vegetation composition and structure closer to historical ranges of variation, to reduce wildfire hazards by decreasing fuel loadings, and to address the successional stage distribution departures from historical landscape levels.

The analysis process used in this project to develop all action alternatives was based on erosional process screens to avoid the highest hazard areas (See Appendix F, which shows the landtype and LTA erosional characteristics of the proposed treatment units by alternative.). As stated above, all units would be analyzed for soil stability concerns during layout based on the historical fire patterns and past landslides and other erosional events. All burns would be conducted when the duff/litter moisture content is high to minimize soil damage and the risk of subsequent erosional events. Forest Plan Standards and Regional Soil Quality Standards will also be met based on the project design methods.

Activities proposed in the action alternatives on potential high landslide hazard landtypes will be modified based on the slope conditions as discussed previously in the mitigation section, so the hazard of mass movements would be maintained within historical levels. Table 3-66 shows (for each alternative) the location of proposed treatment units (by treatment type), the areas with potential high landslide hazard landtypes, and locations of landslides that occurred during the 1995-1996 flood events.

Slope stability issues are the greatest concern with the action alternatives. Proposed treatment units were screened for landtypes with high to very high risks of mass wasting and/or debris avalanches. PACFISH buffers exclude approximately 36-38% of the area of proposed treatment units from harvest activities regardless of alternative. This directly corresponds to the riparian/concave dissection landtype phases, which as has previously been discussed, have the highest risk of landslides. The remaining 62-64% of the treatment areas (depending on alternative) are split between portions on convex, secondary ridge landtype phases, which have a low risk of landslides, and portions of transitional landtype phases, which have a moderate landslide hazard. The following table shows the area of proposed treatments on landtypes with high potential landslide hazards.

Table 3-66: Proposed Treatment Areas on Landtypes with High Potential Landslide Hazards

Alternative	Proposed treatment areas on landtypes with high potential landslide hazards (acres)	Proposed treatment areas with highest landslide hazards within PACFISH buffers (no-harvest zones) (acres/%)	Proposed treatment areas outside PACFISH buffers with low to moderate landslide hazards
2	8393	3065 (36.5%)	5328 (63.5%)
3	8008	2937 (36.7%)	5071 (63.3%)
3A	8018	3024 (37.7%)	4994 (62.3%)
4	2253	845 (37.5%)	1408 (62.5%)
5	7497	2720 (36.3%)	4777 (63.7%)
6	8318	3007 (36.2%)	5311 (63.8%)

The identification of high erosional hazard areas and the prescription of management practices acknowledging these hazards is a proactive approach to addressing future risks. Weather patterns are not predictable over the long-term, so management activities are being prescribed that attempt to restore natural ecological processes, such as wildfire. Landslides and other erosional events are natural processes that have operated across this landscape for thousands of years and will continue to do so in the future. The proposed activities in the North Lochsa Face project have been developed with a strong ecosystem management emphasis that recognizes the natural disturbance processes across the landscape. The highest risk areas would be avoided through application of PACFISH buffers. The remaining treatment areas would retain adequate canopy levels to provide root strength and soil anchoring ability. Therefore, the proposed activities associated with the action alternatives should not increase erosional risks above historical levels, and it is likely that the long-term erosional hazards would be reduced via a reduction of fire hazards on high-risk landforms.

All action alternatives propose similar levels of treatment on landtypes with high potential landslide hazards (7,500 to 8,400 acres), except for Alternative 4. Alternative 4 only prescribes 2,250 acres of treatment. The effects from Alternative 4 would be similar to the no action alternative, since a limited area would be treated to reduce ladder fuels and tree densities.

Cumulative Effects on Soils and Erosional Processes

Geographic Boundary: The geographic area for potential effects on the soil resource from surface erosion is generally limited to immediate treatment boundaries and a buffer of approximately 300 feet around the units. Soil impacts are limited to less than 15% of each activity area, which is analogous to the treatment units. Areas of past detrimental soil impacts within proposed treatment areas should be considered as part of the 15% area of allowable detrimental soil impacts. If past soil impacts exceed 15% of the activity area, the proposed actions will not increase the areal extent of detrimental soil impacts, and attempts will be made, wherever possible, to improve soil conditions in these areas. For a consideration of the potential effects due to landslides and other mass wasting events, the area considered is the entire North Lochsa Face analysis area and downstream portions of the adjacent Lochsa River.

Time Frame: Compaction, displacement, and other detrimental soil impacts can take many years to be restored, so minimization of impacts would be the strategy used. Impacts from tree harvest and/or prescribed burning are considered to extend approximately 20 years after the actions.

Past, Present, and Foreseeable Future Actions: Past actions are included in the description of the existing condition (Chapter Three) and are considered as part of the allowable limit of 15% soil impacts. Present actions include sold, but not completed timber sales (Full Quart, Salt Lick Salvage, and Deadhorse Salvage) and recent wildfires (including

year 2000). Reasonably foreseeable actions within the analysis area include South Sheep, Deadly Moose, and prescribed fire projects.

Impacts to the soil resource were evaluated by determining whether there would be cumulative effects that would exceed the allowable limit of 15% detrimental disturbance. The Forest Service Manual has set this limit to ensure that there is not a significant or permanent impairment of the land (36 CFR 219.27 (a)(1)). Project design would restrict any detrimental impacts to the units. Retention of large woody debris and canopy cover will limit detrimental soil impacts to the unit area. Cumulative soil impacts are generally considered from a timing standpoint rather than spatial aspects. Any past management related soil impacts within a proposed treatment unit would be considered as part of the limit of 15% detrimental soil impacts allowable in the current soil quality standards. Any soil movement off the site is discussed in the watersheds effects section.

Irreversible and Irretrievable Commitment of Resources: This includes the potential loss of the Mazama volcanic ash layer from management activities. This layer has persisted through natural fire and associated erosional processes for over 6700 years. If proposed management activities are of a scale less than historical disturbances, the impacts should maintain the ash layer.

Adverse Effects Which Cannot Be Avoided: Burning and harvesting activities have the potential to displace, heat, compact, and cause other effects to the soil resource. These impacts should be limited to less than 15% of each activity area. Critical areas would be avoided altogether.