3.2 GEOLOGY AND SOILS

3.2.1 Introduction

The study area for the geology and soil analysis in this FEIS is approximately 1,572 acres in size and encompasses the existing White Pass SUP area and the proposed SUP expansion areas ("White Pass Study Area").[22] This section describes the existing condition of geological and soil resources within the White Pass Study Area and the potential impacts from the proposed activities related to the Action Alternatives. The White Pass Study Area encompasses the upper portions of the Upper Tieton River and Upper Clear Fork Cowlitz River watersheds. References frequently used in this section include the *Naches Area Soil Survey* (USDA USFS 1996), *Wenatchee National Forest Land and Resource Management Plan* (WNF Forest Plan) (USDA 1990b), *Gifford Pinchot National Forest Land and Resource Management Plan* (GPNF Forest Plan) (USDA 1990a), and *A Geotechnical Assessment of the White Pass Proposed Expansion* (Wooten 1985). This geology and soil analysis is divided into the following topics: soil compaction, soil productivity, and soil erosion. Geology, soil types and mass wasting are discussed in Appendix F.

3.2.2 Affected Environment

The locations of Soil Groups found within the White Pass Study Area are depicted in Figure 3-6. More detailed descriptions, acreages, underlying geology and landtypes of the Soil Groups found within the White Pass Study Area are located in Appendix F. To evaluate the effects of the Proposed Action on soils, the existing soil compaction, productivity, and soil erosion that currently exist within the White Pass Study Area are described below.

3.2.2.1 Soil Compaction and Productivity

Soil productivity is defined in the GPNF Forest Plan as the capacity of a soil to produce a specific crop such as fiber or forage under defined levels of management (USDA 1990a). Soil productivity is dependant on many factors, such as available soil moisture, soil nutrients, and length of the growing season. Soil productivity is impacted or altered when the topsoil is excessively eroded, covered by an impervious surface, or the topsoil is compacted or mechanically removed by grading or excavation. For the purposes of this FEIS, grading impacts include both the construction of impervious surfaces, as well as other earthwork for site preparation. Site stabilization would include revegetation of exposed soils following the completion of construction, and would not contribute to an area of decreased productivity. Areas where soil productivity has been impacted by the above mentioned activities are defined as "detrimental soil conditions" for the purposes of this document. Impacts such as soil compaction and erosion caused by historic construction of ski lifts and ski trails are measured as a percent of the White

[22]The current SUP indicates that the permit area is 710 acres. However, GIS analysis indicates that the actual SUP area is approximately 805 acres. As a result of this NEPA process, of which this FEIS is a part, the acreage has been re-calculated based on the best available data.

Pass Study Area that is currently in a detrimental soil condition. According to the GPNF Forest Plan and WNF Forest Plan, the total acreage of detrimental soil conditions should not exceed 20 percent within an activity area (USDA 1990a, 1990b). The White Pass Study Area is considered the activity area for purposes of evaluating detrimental soil conditions.

Based on field mapping and GIS analysis, the White Pass Study Area contains eight bare soil areas covering a combined area of approximately 9.2 acres (refer to Table 3.2-1 and Figure 3-7). These bare soil areas were caused by human activities related to ski area management and are all greater than 0.5 acre in size.[23] These bare soil areas are included in calculations of detrimental soil condition. The White Pass Study Area also contains approximately 35.9 acres of existing impervious surfaces that are comprised of existing roads, buildings, and parking lots (refer to Table 3.2-1). The total area of existing detrimental soil conditions is approximately 45.1 acres, which is approximately 2.9 percent of the White Pass Study Area. Since the GPNF Forest Plan and WNF Forest Plan standard for detrimental soil conditions is 20 percent, the White Pass Study Area is currently in compliance with these standards (USDA 1990a, 1990b).

Table 3.2-1:
Existing Soil Productivity Conditions
within the White Pass Study Area

Parameter	Existing Conditions
White Pass Study Area (acres)	1570.0
Bare Soil Areas (acres)[a]	9.2
Impervious Surfaces (acres)[b]	35.9
Area of Detrimental Conditions (acres)[c]	**45.1**
Percent of White Pass Study Area in Detrimental Conditions	**2.9%**

[a] Bare soil areas are existing, human-caused unvegetated areas larger than 0.5 acre.
[b] Impervious surfaces are long-term impacts such as buildings, roads, and lift terminal.
[c] Detrimental soils include all developed areas (roads, building, etc.) and bare soil areas

3.2.2.2 Soil Erosion

Soil erosion and sediment deposition are indirect effects to soil productivity whose extent is dependent on the intensity of the impact and the presence of a transport mechanism such as water, wind, or gravity. Soil surfaces that are temporarily or constantly maintained in a non-vegetated condition are generally more erodible than vegetated soil. Vegetation growth increasingly stabilizes soil, thus sharply reducing the potential for soil erosion and sediment deposition. To describe the range of erodible conditions within the

[23] Based on best available data (field and GIS analysis) the 0.5-acre threshold was determined to be appropriate. Bare soil areas smaller than 0.5 acre may exist on-site, however the sum total of these smaller areas would not increase the percentage of White Pass Study Area in detrimental conditions above the GPNF and WNF Forest Plan compliance standard of 20 percent.

White Pass Study Area, three soil erosion hazard classes were evaluated. Low erosion hazard soil has few erosive properties, is typically located on flat slopes, and poses the lowest risk of surface erosion. Moderate erosion class soil typically occurs on slopes of moderate steepness and has an intermediate erosion hazard. High erosion hazard soil is typically more erosive and is located on steeper slopes, and poses the highest risk of surface erosion. This analysis is intended to describe the risk of surface erosion and does not imply that low and moderate stability soil would not erode under specific management activities, nor does it imply that high erosion hazard soil will always severely erode following clearing and grading activities. All management activities in forested mountainous landscapes generate some increased risk of erosion. Actual erosion, however, also depends on the degree of impact and the effectiveness of Mitigation Measures used.

The acreage of each erosion hazard class within the White Pass Study Area is given in Table 3.2-2 and the distribution of the soil erosion hazard classes within the White Pass Study Area is shown in Figure 3-7. The majority of the soil within the White Pass Study Area (77 percent) is classified as medium erosion hazard, covering approximately 1,201.1 acres. Medium erosion hazard soil is generally found on low to moderate gradient slopes in the upper elevation portions of the existing and proposed SUP areas. Approximately 98.0 acres of high erosion hazard soil is generally located on steep to very steep slopes near the cliff band in the existing ski area (Landtype B) and in some of the lower elevation ski trails (refer to Figure 3-7). Soil that has a low erosion hazard covers approximately 191.0 acres within the White Pass Study Area and is located primarily in low to moderate gradient forested areas and in some very flat meadows in the proposed SUP expansion area.

Table 3.2-2:
Summary of Soil Erosion Hazard
Within the White Pass Study Area

Erosion Hazard	Alt. 1 Existing Conditions	Alt. 1 Existing Impacts
High (acres)	98.0	1.7
Medium (acres)	1,201.1	29.3
Low (acres)	191.0	14.1
N/A (acres)	79.1	0.0
Total (acres)	**1569.2**	**45.1**

Note: Totals may vary due to rounding.

Approximately 45.1 acres of existing developed areas (e.g., roads, buildings, and chairlifts) and bare soil areas within the White Pass Study Area are located predominantly (approximately 65 percent) on medium erosion hazard soils. The remaining developed and bare soil areas in the White Pass Study Area have impacted approximately 1.7 acres of high erosion hazard soils (4 percent) and approximately 14.1 acres (31 percent) of low hazard soils. The distribution of existing developed areas within the White Pass Study Area indicates that many of the potential impacts to high erosion hazard soils have been avoided and that

the White Pass Ski Area has not significantly increased the erosion hazard within the White Pass Study Area. Field observations of ski trails and roads within the existing ski area did not identify any areas with significant erosion or gullying and most of the ski trails were in a well vegetated condition. Approximately 9.2 acres of bare soils were identified and mapped within the existing ski area, but most of these areas did not have excessive erosion, and revegetation and erosion control measures were in place.

The Watershed Erosion Prediction Project (WEPP) model developed by the US Department of Agriculture's Agricultural Research Service was used to estimate soil detachment within the Upper Tieton and Upper Clear Fork Cowlitz watersheds in the White Pass Study Area. As described in Appendix L, the WEPP analysis is based on generic hillslopes that have been customized with climate, soil, and vegetation data specific to the White Pass Study Area.

3.2.3 Environmental Consequences

Impact mechanisms to soil resources within the White Pass Study Area include direct, indirect, short-term, and long-term impacts to soil resources. Direct impacts typically have immediate effects in the area of activity and would include construction of impervious surfaces, clearing, and grading activities that would result in the modification of the topography and soils, utility trenching, and restoration activities. Indirect impacts are delayed or unforeseen effects that occur in the future or in a different location than the original action, and include impacts such as altered drainage patterns from construction activities that may increase erosion, clearing activities which may increase erosion and/or nutrient inputs, road and trail maintenance, and restoration activities. Short-term impacts to soil would include temporary disturbances such as the clearing of vegetation, grading areas that would be revegetated, and utility trenching. Long-term impacts include road construction, parking lot construction, lift terminal and tower construction, and building construction.

3.2.3.1 Soil Compaction and Productivity

Alternative 1

There are no proposed activities in the White Pass Study Area under Alternative 1. Currently, approximately 45.1 acres (2.9 percent) of the White Pass Study Area has existing detrimental soil conditions resulting from historic ski area development. There would be no additional direct or indirect impacts to soil productivity under Alternative 1, and the White Pass Study Area would remain consistent with GPNF Forest Plan and WNF Forest Plan standards.

Alternative 2

Under Alternative 2, construction of the mid-mountain lodge, lift terminals and lift towers would have the greatest impact on soil productivity as compared to other proposed activities (such as the clearing of vegetation), because soil production would be eliminated by the creation of new impervious surfaces. **The total area of long-term soil impacts from the creation of impervious surfaces under Alternative 2**

would be approximately 0.1 acre. Soil productivity would also be reduced over the short-term within the White Pass Study Area by approximately 4.8 acres of proposed grading, which would include utility trenching, that would be revegetated with native vegetation after construction is completed. Grading impacts to soil productivity would be caused by removing and/or mixing the top soil, which changes the physical properties of the soil and slows the recovery of vegetation. The potential impacts from grading would be minimized to ensure that impacts are only short-term through the implementation of Mitigation Measure MM11 (refer to Table 2.4-2),development of a Travel Route Plan (TRP), use of low impact construction equipment, and other methods to reduce incidental soil compaction and mechanical disturbance. Other Management Provisions that would be implemented include the creation of a SWPPP to reduce erosion impacts, preservation and reapplication of topsoil in graded areas, and not allowing construction during unfavorable weather conditions (refer to OMP1, OMP2, and OMP4 in Table 2.4-4).

Due to the development of a TRP as part of the SWPPP, and other Mitigation Measures such as transporting equipment over the snow and/or slash and downed logs, there would be no new soil compaction within the White Pass Study Area (refer to Appendix F). The TRP would also specify conditions that must be met for over-ground access for construction equipment (refer to MM11 in Table 2.4-2). Other Management Requirements that would be implemented in conjunction with the TRP include the use of low pressure tires on construction equipment and the prohibition of vehicles driving over ground in the White Pass Study Area during inclement weather (refer to MR16 and MR17 in Table 2.4-3). Because of these Mitigation Measures and Management Requirements, there would be no soil compaction within the White Pass Study Area that would lead to additional detrimental soil conditions during implementation of Alternative 2.

Under Alternative 2, approximately 0.1 acre of impervious surfaces would be added to the approximately 45.1 acres of existing detrimental soil conditions. Therefore, the total area of detrimental soil conditions within the White Pass Study Area would remain at 2.9 percent under Alternative 2, well below the 20 percent threshold, consistent with GPNF Forest Plan and WNF Forest Plan standards.

Table 3.2-3:
Potential Impacts to Soil Resources Within the White Pass Study Area

Parameter	Alt. 1 Existing Condition	Alt. 2 Impacts	Mod. Alt. 4 Impacts	Alt. 6 Impacts	Alt. 9 Impacts
Short-term Soil Impacts from Clearing (acres)[a]	N/A	14.9	23.6	9.6	27.0
Short-term Soil Impacts from Grading (acres)[a]	N/A	4.8	12.8	1.2	1.2
Long-term Soil Impacts (acres)[b]	35.9	0.1	8.1	4.5	10.7
Total Soil Impacts (acres)	**35.9**	**19.8**	**44.4**	**15.3**	**38.9**
Area of Detrimental Soil Conditions (acres)	**45.1[c]**	**45.2**	**53.2**	**49.6**	**55.8**
Percent of White Pass Study Area w/ detrimental soil conditions	**2.9%**	**2.9%**	**3.4%**	**3.2%**	**3.6%**

[a]Short-term soil impacts are equivalent to proposed clearing and grading, including trenching that would be revegetated.
[b]Long-term soil impacts are equivalent to all proposed impervious surfaces (buildings, new roads, parking lots, etc.).
[c]The area of detrimental soil conditions for Alternative 1 includes both impervious surfaces and bare soil area.
Note: Totals may vary due to rounding.

The proposed 14.9 acres of tree clearing for tree island removal and full clearing to construct the trails for the *Basin* pod and the *Hogback Express* pod would also result in short-term impacts to soil productivity. Short-term soil productivity impacts from tree clearing are lower intensity impacts as compared to short-term impacts from grading and could be caused by incidental soil compaction from the operation of logging equipment and disturbing the duff layer from tree felling and related activities. Implementation of a TRP, as specified in Mitigation Measure MM11 (refer to Table 2.4-2), and Other Management Provisions, such as the creation of a SWPPP to reduce erosion impacts and not allowing construction during inclement weather conditions (OMP1 and OMP4 in Table 2.4-4), would reduce potential short-term clearing impacts to soil.

Under Alternative 2, approximately 19.8 acres of total land would be cleared and/or graded to create the lift corridors and ski trails in the proposed expansion area. The removal of tree islands in the mountain hemlock parkland vegetation community would also indirectly impact soil quality, and therefore soil productivity by reducing litter and woody debris inputs and slowing the formation of the organic duff layer. Vehicles and equipment operating near the perimeter of constructed impervious surfaces and proposed clearing could further reduce soil productivity through the compaction and puddling of soil. Restoration of this lost productivity could be very slow due to the cold soil temperatures, short growing season, and low fertility. Through the use of the construction techniques listed in Table 2.4-1 and the creation of a TRP, as specified in Mitigation Measure MM11 (refer to Table 2.4-2), as well as following

Other Management Provisions OMP1 and OMP4, which call for a creation of a SWPPP to reduce erosion impacts and not allowing construction during inclement weather conditions (refer to Table 2.4-4), potential soil compaction, erosion, and overall loss of soil productivity would be reduced.

Modified Alternative 4

The construction of the proposed parking lot and grading for Trail *4-16* and Trail *4-18* would have the greatest relative impact on soil productivity, as compared to other proposed activities under Modified Alternative 4, due to the larger area of impervious surfaces and extensive cut and fill excavation proposed. **The total area of long-term soil impacts from the creation of impervious surfaces under Modified Alternative 4 would be approximately 8.1 acres**, which would be the second largest increase in impervious surfaces, after Alternative 9, of all Action Alternatives. Soil productivity would also be reduced over the short-term within the White Pass Study Area by approximately 12.8 acres of proposed grading that would be revegetated with native vegetation after construction is completed. The short-term grading impacts from Modified Alternative 4 are the largest as compared to the other Action Alternatives due primarily to the addition of trails 4-16, 4-17, 4-18, minimal grading to Holiday, the 7-acre parking lot, the perimeter grading around the proposed parking lot, and the additional trenching width for the water utility line (unless it is determined that installation of a waterline in conjunction with the utility trenching would significantly impact streams and wetlands, in which case an on-site well would be located upslope of the mid-mountain lodge, within the 50-foot disturbance corridor surrounding the lodge). For further discussion on the addition of these trails, refer to Chapter 2 and Section 3.11. The potential impacts from grading would be minimized to ensure that impacts are only short-term through the implementation of Mitigation Measure MM11 (refer to Table 2.4-2). This would reduce grading impacts to soil productivity through the development of a TRP, use of low impact construction equipment, and other methods to reduce incidental soil compaction and mechanical disturbance. Other Management Provisions that would be implemented include the creation of a SWPPP to reduce erosion impacts, preservation and reapplication of topsoil in graded areas, and not allowing construction during inclement weather conditions (refer to OMP1, OMP2, and OMP4 in Table 2.4-4).

Under Modified Alternative 4, approximately 8.1 acres of impervious surfaces would be added to the 45.1 acres of existing detrimental soil conditions. Therefore, the total area of detrimental soil conditions within the White Pass Study Area would increase from approximately 2.9 percent to 3.4 percent under Modified Alternative 4. However, the percent of detrimental soil conditions under Modified Alternative 4 would remain below the GPNF Forest Plan and WNF Forest Plan standard of 20 percent (USDA 1990a, 1990b; USDA and USDI 1994).

Approximately 23.6 acres of proposed tree clearing under Modified Alternative 4 (associated with the construction of the trails for the *Basin* pod, the *Hogback Express* pod, and trails 4-17 and 4-18) would result in short-term impacts to soil productivity. Modified Alternative 4 would result in the second largest short-term clearing impact to soils, after Alternative 9, because of the addition of trails 4-

16, 4-17, 4-18, grading to the Holiday trail, the PCNST re-route, and the proposed new 7-acre parking lot in this alternative. Proper implementation of a TRP, as specified in Mitigation Measure MM11 (refer to Table 2.4-2), through use of low impact construction equipment and methods would reduce incidental soil compaction and mechanical disturbance. Other Management Provisions would also reduce potential short-term, clearing impacts to soil via the creation of a SWPPP and not allowing construction during inclement weather conditions (OMP1 and OMP4 in Table 2.4-4).

The total area of new soil impacts under Modified Alternative 4 would be approximately 44.4 acres, which would create indirect impacts to soil productivity in the immediate vicinity of these direct impacts. Through the use of construction techniques listed in Table 2.4-1 and the creation of a TRP as specified in Mitigation Measure MM11 (refer to Table 2.4-2), as well as following Other Management Provisions OMP1 and OMP4, which call for the creation of a SWPPP to reduce erosion impacts and not allowing construction during inclement weather conditions (refer to Table 2.4-4), potential soil compaction, erosion, and overall loss of soil productivity would be reduced.

Under Modified Alternative 4, a 2,000-foot segment of the PCNST would be rerouted to the south of the proposed upper terminal of the *Basin* chairlift, as described in Section 2.3.4.7. Rerouting would consist of constructing a 24-inch tread within a 6-foot wide corridor cleared of woody vegetation, resulting in 0.12 acre of soil disturbance. This impact to soils would indirectly affect the soil productivity in these areas through compaction, by reducing litter and woody debris inputs, and slowing the formation of the organic duff layer.

Alternative 6

The greatest relative impact to soil productivity, as compared to other proposed activities under Alternative 6, would be the construction of the proposed parking lot and road to the bottom terminal of the *Basin* chairlift due to the larger area of impervious surfaces proposed. **Under Alternative 6, the total area of long-term soil impacts from the creation of impervious surfaces would be approximately 4.5 acres. Soil productivity would also be reduced over the short-term within the White Pass Study Area by approximately 1.2 acres due to proposed grading that would be revegetated with native vegetation after construction is completed.** The short-term grading impacts from Alternative 6 are lower than from Alternative 2 and Modified Alternative 4 because the additional length of utility trenching for the construction of the *Hogback Express* chairlift would not be necessary. The proposed impacts from grading would be minimized to ensure that impacts are only short-term through the implementation of Mitigation Measure MM11 (refer to Table 2.4-2), which would reduce grading impacts to soil productivity though the creation of a TRP, low impact construction equipment, and methods to reduce incidental soil compaction and mechanical disturbance. Other Management Provisions that would be implemented include the creation of a SWPPP to reduce erosion impacts, preservation and reapplication of topsoil in graded areas, and not allowing construction during inclement weather conditions (refer to OMP1, OMP2, and OMP4 in Table 2.4-4).

Under Alternative 6, approximately 4.5 acres of impervious surfaces would be added to the 45.1 acres of existing detrimental soil conditions. Therefore, the total area of detrimental soil conditions within the White Pass Study Area would increase from approximately 2.9 percent to 3.2 percent under Alternative 6. As a result, Alternative 6 would maintain detrimental soil conditions below 20 percent and would be consistent with the GPNF Forest Plan and WNF Forest Plan standards.

The proposed 9.6 acres of tree clearing under Alternative 6 for construction of the trails for the *Basin* pod would create short-term impacts to soil productivity. However, implementation of Alternative 6 would create the smallest increase in short-term clearing impacts to soils of all the Action Alternatives, because it does not include the *Hogback Express* chair and associated trails. Proper implementation of a TRP as specified in Mitigation Measure MM11 (refer to Table 2.4-2) and Other Management Provisions, such as the creation of a SWPPP to reduce erosion impacts and not allowing construction during inclement weather conditions (OMP1 and OMP4 in Table 2.4-4), would reduce potential short-term clearing impacts to soil.

The total area of new soil impacts under Alternative 6 would be approximately 15.3 acres, and would create indirect impacts to soil productivity in the immediate vicinity of these direct impacts. Implementation of the methods and techniques specified in Table 2.4-1, Mitigation Measure MM11 (refer to Table 2.4-2) and Other Management Provisions OMP1 and OMP4 (refer to Table 2.4-4) would reduce the potential short-term clearing impacts to soils.

Under Alternative 6, 0.6 mile of road obliteration is proposed before the construction of the 0.25-mile proposed new road. This road decommissioning would be addressed at a later time when more details are known, and would be addressed in a separate NEPA analysis.

Alternative 9

The construction of the *PCT* chairlift and associated trails, proposed parking lot, grading for the alternate egress trail near the base area, and additional trails within the Paradise pod would have the greatest relative impact on soil productivity, as compared to the other proposed activities under Alternative 9, due to the large area of impervious surfaces and extensive cut and fill excavation proposed for these components. **The total area of long-term soil impacts from the creation of impervious surfaces under Alternative 9 would be approximately 10.7 acres,** the largest increase in impervious surfaces among the Action Alternatives. **Soil productivity within the White Pass Study Area would be reduced over the short-term by the grading of approximately 1.2 acres**. The proposed impacts from grading would be minimized to ensure that impacts are only short-term through the implementation of Mitigation Measure MM11 (refer to Table 2.4-2), which would reduce grading impacts to soil productivity though the creation of a TRP, the use of low impact construction equipment, and implementation of methods to reduce incidental soil compaction and mechanical disturbance. Other Management Provisions that would be implemented include the creation of a SWPPP to reduce erosion impacts, preservation and

reapplication of topsoil in graded areas, and not allowing construction during inclement weather conditions (refer to OMP1, OMP2, and OMP4 in Table 2.4-4).

Under Alternative 9, approximately 10.7 acres of impervious surfaces would be added to the 45.1 acres of existing detrimental soil conditions. Therefore, the total area of detrimental soil conditions within the White Pass Study Area would increase from approximately 2.9 percent to 3.6 percent under Alternative 9. As a result, Alternative 9 would maintain detrimental soil conditions below 20 percent and would remain consistent with the GPNF Forest Plan and WNF Forest Plan standards.

The proposed 27.0 acres of tree clearing under Alternative 9 for construction of the *PCT* pod would create short-term impacts to soil productivity. Alternative 9 would create the largest short-term clearing impact to soils because of the extensive full clearing prescription required for this ski pod, relative to the selective tree island removal that would be required under the other Action Alternatives for construction of trails in the proposed SUP expansion area. Proper implementation of a TRP as specified in Mitigation Measure MM11 (refer to Table 2.4-2) and Other Management Provisions, such as the creation of a SWPPP to reduce erosion impacts and not allowing construction during inclement weather conditions (OMP1 and OMP4 in Table 2.4-4), would reduce potential short-term, clearing impacts to soil.

Under Alternative 9, a 225-foot segment of the PCNST would be rerouted to the east to avoid passing through a proposed ski trail in the northeastern side of the existing SUP area, as described in Section 2.3.6.7. Rerouting would consist of constructing a 24-inch tread within a 6-foot wide corridor cleared of woody vegetation, resulting in 0.1 acre of soil disturbance. This impact to soils would indirectly affect the soil productivity in these areas through compaction, by reducing litter and woody debris inputs, and slowing the formation of the organic duff layer.

The total area of new soil impacts under Alternative 9 would be 38.9 acres, which would also create indirect impacts to soil productivity in the immediate vicinity of these direct impacts. Through the use of construction techniques listed in Table 2.4-1 and the creation of a TRP as specified in Mitigation Measure MM11 (refer to Table 2.4-2), as well as following Other Management Provisions OMP1 and OMP4, which call for the creation of a SWPPP to reduce erosion impacts and not allowing construction during inclement weather conditions (refer to Table 2.4-4), soil compaction, erosion, and overall loss of soil productivity would be reduced.

3.2.3.2 Soil Erosion

The U.S. Department of Agriculture Agricultural Research Service's WEPP model has been used to quantify sediment production due to changes in land cover associated with the alternatives. The model was used to compute detachment only, and does not account for routing and buffering, which reduce actual yields to streams. Since the analysis did not account for factors that can result in the removal and deposition of sediment from water before reaching a surface water body, it represents a conservative

analysis (i.e., it overestimates the contribution of sediment to the watersheds). For additional information regarding the WEPP model, refer to Appendix L. Also, additional information on soil detachment can be found in Section 3.3 – Watershed Resources.

Alternative 1

There are no proposed activities in the White Pass Study Area under Alternative 1. Therefore, soil erosion conditions would remain unchanged, as shown in Table 3.2-2. As described in Appendix L, WEPP modeling estimated a soil detachment of approximately 103.1 tons per year within the Upper Clear Fork Cowlitz watershed and 133.6 tons per year in the Upper Tieton watershed.

Alternative 2

Under Alternative 2, approximately 0.1 acres of tree clearing and 4.8 acres of grading would occur to construct two new lifts, build the mid-mountain lodge, trench in the utilities. Within the 4.8 acres of proposed grading, the majority of it, approximately 4.5 acres, would occur on moderate erosion hazard soil (refer to Table 3.2-4). Under Alternative 2, no proposed grading would occur on high erosion hazard soil. The proposed grading at the bottom lift terminals of both the *Basin* and *Hogback Express* chairlifts represents the largest potential source of sediment to waterbodies under Alternative 2, and would be the primary management concern. However, the erosion hazard in the vicinity of the bottom terminals is low due to the low slope gradients in the area. Since no permanent or temporary roads are proposed under Alternative 2, the permanent road density in the White Pass Study Area would not change, and there would be no new stream crossings by roads, resulting in no new sediment yield to streams from roads. Mitigation Measure MM11 in Table 2.4-2, Management Requirement MR15 in Table 2.4-3, and Other Management Provisions OMP1, OMP2, OMP3, and OMP4 in Table 2.4-4 would be implemented to minimize soil erosion impacts.

Table 3.2-4:
Grading Impacts to Soils by Erosion Hazard Class within the White Pass Study Area

Erosion Hazard	Alt. 1 Existing Impacts	Alt. 2 Impacts	Mod. Alt. 4 Impacts	Alt. 6 Impacts	Alt. 9 Impacts
High (acres)	1.7	0.0	1.4	0.0	1.2
Medium (acres)	29.3	4.5	10.8	2.5	4.5
Low (acres)	14.1	0.3	7.5	3.1	6.2
N/A (acres)	0.0	0.0	0.0	0.0	0.0
Total (acres)	**45.1**[a]	**4.8**	**19.6**	**5.6**	**11.9**

[a]Refer to Section 3.2.3.1 describing that grading impacts to soils are pre-existing detrimental soil conditions resulting from historic ski area development. Note that totals may vary due to rounding.

It is anticipated that temporary minor increases in soil erosion and sediment delivery to streams would probably occur with trail grading and possibly other ground disturbances, such as utility trenching,

although the use of sediment control BMPs and Other Management Provisions OMP1, OMP2, and OMP4 listed in Table 2.4-4 would minimize this risk.

As described in Appendix L, the WEPP model estimated approximately 126.5 tons per year of soil detachment following construction activities in the Upper Clear Fork Cowlitz watershed, a short-term increase of approximately 23 percent over existing detachment (refer to Table 3.2 FEIS1). Following the stabilization of exposed soils and allowing for recovery (approximately two to five years), long-term soil detachment would increase approximately 4 percent to 107.2 tons per year. Within the Upper Tieton watershed, there would be no change to the estimated soil detachment as no construction activities would occur in that watershed under Alternative 2.

Table 3.2 FEIS1:
WEPP Model Estimates of Soil Detachment

Soil Detachment	Alt. 2		Mod. Alt. 4		Alt. 6		Alt. 9	
	Upper Clear Fork Cowlitz	Upper Tieton	Upper Clear Fork Cowlitz	Upper Tieton	Upper Clear Fork Cowlitz	Upper Tieton	Upper Clear Fork Cowlitz	Upper Tieton
Short-term (tons/yr)	126.5	133.7	173.1	133.8	112.7	133.8	131.8	150.8
Short-term Increase (%)	23%	0.0%	68%	0.1%	9%	0.1%	28%	12.8%
Long-term (tons/yr)	107.2	133.7	113.3	133.9	107.8	133.7	106.6	134.8
Long-term Increase (%)	4%	0.0%	10%	0.2%	5%	0.1%	3%	0.8%

Note: WEPP model estimates of soil detachment for Alternative 1 are described in Table 3.3 FEIS 3

Disturbed areas resulting from construction activities would most likely be difficult to revegetate because of the short growing season, cold climate and low soil fertility. Implementation of Other Management Provisions to protect exposed soil surfaces, including the use of seeding and protective mulches, is most important to prevent increased sedimentation and overland flow under all Action Alternatives. These management provisions have been successful in other high elevation ski areas such as The Summit at Snoqualmie (SE Group 2003), Mount Ashland (USDA 2003), and Mount Bachelor (SE Group unpublished data) in the Cascade Range (refer to Other Management Provisions OMP1 and OMP2).

Modified Alternative 4

Under Modified Alternative 4, approximately 19.6 acres of grading, the most of any Action Alternative, would occur to construct two new lifts, the mid-mountain lodge, trench in utilities (including a waterline), grade trails 4-2, 4-16, 4-18 and Holiday, and construct a new parking lot. Within the 19.6 acres of proposed grading, the majority, approximately 10.8 acres, would occur on moderate erosion hazard soil (refer to Table 3.2-4). Under Modified Alternative 4, approximately 1.4 acres of grading would occur on high erosion hazard soil, the most of all Action Alternatives. The proposed grading for Trail 4-16 from the *Hogback Express* chairlift and Trail 4-18 represents the largest potential source of sediment to waterbodies due to the steep, erosion-prone soil and proximity to streams. However, Management

Requirements MR4 and MR5 (refer to Table 2.4-3) along with Other Management Practice OMP1 (refer to Table 2.4-4) would be implemented to minimize soil erosion impacts.

Since no permanent or temporary roads are proposed under Modified Alternative 4, the permanent road density in the White Pass Study Area would not change. As there would be no new road stream crossings, there would be no new sediment yield to streams from road crossings. However, a 7-acre parking lot would be constructed under Modified Alternative 4 in the northeast corner of the SUP area adjacent to two streams and a wetland. The soil in this area has a low erosion hazard and the slope gradient is low, therefore, implementation of Mitigation Measure MM11 in Table 2.4-2, Management Requirement MR15 in Table 2.4-3, and Other Management Provisions OMP1, OMP2, OMP3, and OMP4 from Table 2.4-4 would likely reduce or eliminate the potential for sediment delivery to these streams.

It is anticipated that temporary minor increases in soil erosion and sediment delivery to streams would probably occur due to trail grading and possibly other ground disturbances, such as utility trenching. However, the use of sediment control BMPs and Other Management Provisions OMP1, OMP2, and OMP4 listed in Table 2.4-4 would minimize this risk.

Short-term soil detachment within the Upper Clear Fork Cowlitz watershed under Modified Alternative 4 would increase approximately 68 percent, the most of any alternative, to 173.1 tons per year (refer to Table 3.2 FEIS1). Long-term soil detachment would increase by approximately 10 percent to 113.3 tons per year. Within the Upper Tieton watershed, short-term soil detachment would increase by approximately 0.1 percent to 133.8 tons per year. Long-term soil detachment in the Upper Tieton watershed would increase approximately 0.2 percent to 133.9 tons per year.

Under Modified Alternative 4, the PCNST would be rerouted around the proposed upper terminal of the *Basin* chairlift as described in Section 2.3.4.7. Rerouting would consist of 24-inch tread within a 6-foot corridor cleared of woody vegetation, resulting in approximately 0.12 acre of soil disturbance. This impact to soils would be on moderate erosion hazard soil, so through the use of BMPs and Mitigation Measures, Management Requirements, and Other Management Provisions, any erosion occurring would be minimized.

An on-site well would be drilled to provide a water supply for the proposed mid-mountain lodge if the installation of a waterline in conjunction with the utility trenching would significantly impact streams and wetlands. The well would be located upslope of the mid-mountain lodge, within the 50-foot disturbance corridor surrounding the lodge (refer to Section 3.13 – Utilities and Infrastructure).

Alternative 6

Under Alternative 6, approximately 5.6 acres of grading would occur to construct one new lift, build the mid-mountain lodge, trench in utilities, construct a road to the bottom terminal of the *Basin* chairlift, build a parking lot, and grade Trail 6-1. Of the 5.6 acres of proposed grading, the majority of it, approximately

3.1 acres, would occur on low erosion hazard soil (refer to Table 3.2-4). Under Alternative 6, no grading would occur on high erosion hazard soil, but approximately 2.5 acres of medium erosion hazard soil would be graded. The construction of the proposed road to the bottom terminal of the *Basin* chairlift represents the greatest potential source of sediment to waterbodies under Alternative 6, due to the four proposed stream crossings and indirect impacts to adjacent wetlands. While some additional sediment yield is anticipated from this project, the proposed road would only be located in low and moderate erosion hazard soils and Mitigation Measure MM11 (refer to Table 2.4-2) and Other Management Provisions OMP1, OMP2, OMP3, and OMP4 (refer to Table 2.4-4) would be implemented to minimize soil erosion impacts.

Additionally, under Alternative 6, a 2.5-acre parking lot would be constructed in the northeast corner of the SUP area, adjacent to two streams and a wetland. BMPs and Mitigation Measures (refer to Table 2.4-2) would be implemented to eliminate additional sediment delivery to nearby streams from construction impacts. The soil in this area has a low erosion hazard and the slope gradient is low, therefore, implementation of Mitigation Measure MM11 in Table 2.4-2, Management Requirement MR15 in Table 2.4-3, and Other Management Provisions OMP1, OMP2, OMP3, and OMP4 from Table 2.4-4 would likely reduce or eliminate the potential for sediment delivery to these streams.

Temporary minor increases in soil erosion and sediment delivery to streams would probably occur with trail grading and possibly other ground disturbances, such as utility trenching. However, the use of sediment control BMPs and Other Management Provisions OMP1, OMP2, and OMP4 listed in Table 2.4-4 would minimize this risk.

Short-term soil detachment within the Upper Clear Fork Cowlitz watershed under Alternative 6 would increase approximately 9 percent, the least of any alternative, to 112.7 tons per year (refer to Table 3.2 FEIS1). Long-term soil detachment would increase by approximately 5 percent to 107.8 tons per year. Within the Upper Tieton watershed, short and long-term soil detachment would increase by approximately 0.1 percent to 133.8 tons per year.

Under Alternative 6, 0.6 mile of road obliteration is proposed to occur prior to the construction of the 0.25-mile proposed new road. This road decommissioning would be addressed at a later time when more details are known and would require a separate NEPA analysis.

Alternative 9

Under Alternative 9, approximately 11.9 acres of grading would occur to construct one new lift within the existing SUP area, build a 2.5-acre parking lot, build a mountain-top lodge, trench for utilities, and construct/regrade trails (including trails 9-2, 9-6, Platter, Holiday and Farside). Of the 11.9 acres of proposed grading, the majority of it, approximately 6.2 acres, would occur on low erosion hazard soil and approximately 4.5 acres would occur on medium erosion hazard soil (refer to Table 3.2-4). Under

Alternative 9, approximately 1.2 acres of grading would occur on high erosion hazard soil. The proposed grading for the alternate egress trail from the Paradise pod and for ski trails that cross streams near the bottom of the *PCT* pod represent the largest potential source of sediment to waterbodies under Alternative 9, and would be a primary management concern. Mitigation Measure MM11 in Table 2.4-2, Management Requirement MR15 in Table 2.4-3, and Other Management Provisions OMP1, OMP2, and OMP3, from Table 2.4-4 would be implemented to minimize soil erosion impacts.

Since no permanent or temporary roads are proposed under Alternative 9, the permanent road density in the White Pass Study Area would not change. As there would be no new road stream crossings, there would be no new sediment yield to streams from road crossings. However, in Alternative 9, a 2.5-acre parking lot would be constructed in the northeast corner of the SUP area, adjacent to two streams and a wetland. The soil in this area has a low erosion hazard and the slope gradient is low, therefore, implementation of Mitigation Measure MM11 in Table 2.4-2, Management Requirement MR15 in Table 2.4-3, and Other Management Provisions OMP1, OMP2, OMP3, and OMP4 from Table 2.4-4 would likely at least reduce, if not eliminate, the potential for sediment delivery to these streams.

Under Alternative 9, 225 feet of the Pacific Crest National Scenic Trail would be rerouted to a nearby forested area to avoid passing through a new ski trail, as described in Section 2.3.6.7. The trail reroute would result in the construction of approximately 225 feet of trail with 24-inch tread that would be created through the middle of a 6-foot corridor cleared of woody vegetation. The new trail construction would require approximately 0.01 acre of ground disturbance, while the retired portion of the PCNST would be incorporated into a new ski trail and would not be restored to original forested conditions. This acreage of impacts to soil would be on moderate erosion hazard soil, and through the use of BMPs and Mitigation Measures, any erosion occurring would be minimized.

It is anticipated that temporary minor increases in soil erosion and sediment delivery to streams would probably occur with trail grading and possibly other ground disturbances, such as utility trenching. However, the use of sediment control BMPs and Other Management Provisions OMP1, OMP2, and OMP4 listed in Table 2.4-4 would minimize this risk.

Short-term soil detachment within the Upper Clear Fork Cowlitz watershed under Alternative 9 would increase approximately 28 percent to 131.8 tons per year (refer to Table 3.2 FEIS1). Long-term soil detachment would increase by approximately 3 percent to 106.6 tons per year. Within the Upper Tieton watershed, short-term soil detachment would increase by approximately 12.8 percent to 150.8 tons per year, the most of any Action Alternative. Long-term soil detachment within the Upper Tieton watershed would increase by approximately 0.8 percent to 134.8 tons per year.

3.2.4 Cumulative Effects

A cumulative effects analysis was performed for each watershed at the site scale (White Pass Study Area) and 5th field watershed scale (Upper Clear Fork Cowlitz and Upper Tieton). Within the discussions below, cumulative impacts to geology and soils are considered for short-term and long-term impacts. Cumulative impacts are evaluated on a short-term basis using increases in erodible soil, which is considered a short-term detrimental soil condition. As construction sites stabilize and revegetate, the detrimental soil condition is lessened. Typically, construction documents and permit requirements necessitate the revegetation and stabilization of exposed soils to promote quick stabilization, thereby reducing the potential for long-term detrimental soil conditions. Increased detrimental soil conditions have the potential to affect sediment mobilization and impact areas downstream in the watershed.

Long-term effects to geology and soil resources occur from a loss of geologic stability or soil productivity. The construction of impervious surfaces serves as a surrogate for measuring long-term losses in soil productivity. The replacement of soils with impervious surfaces also alters the soil permeability and its ability to absorb water. No identified cumulative effects would alter geologic stability, therefore geologic stability is not discussed in this cumulative effects analysis.

3.2.4.1 Upper Clear Fork Cowlitz Watershed

A list of all projects occurring within the Upper Clear Fork Cowlitz (refer to Table 3.2-5) and the effects to geology and soil resources are presented below. For a description of project actions, refer to Table 3.0-FEIS1.

Table 3.2-5:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Clear Fork Cowlitz Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UCFC-2	Forest Road 4600 Stabilization	Approximately 0.1 acre of short-term, direct impacts to soils occurred through the installation of riprap at the culvert inlet. Although the site has been stabilized (i.e., no short-term detrimental soil conditions overlap temporally with the effects of the White Pass expansion), the effects of the loss of soil productivity due to this project temporally overlap with the effects of the White Pass expansion. There is no spatial overlap with the White Pass Study Area. Combined with the other projects identified in this table, in the long-term, this project contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil by rip rap.
UCFC-3a	Palisades Scenic Viewpoint Project	Long-term direct impacts to soils occurred through the creation of less than 0.5 acre of impervious surfaces within the existing disturbed area. There is no spatial overlap with the White Pass Study Area. Long-term project effects would temporally overlap with the effects of the White Pass expansion. In the long-term, this project contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil by impervious surface.

Table 3.2-5:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Clear Fork Cowlitz Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UCFC-3b	Palisades Scenic Viewpoint Project Vegetation Mgmt	Approximately 1 acre of trees will be felled and left onsite as woody material. Spatially this project does not overlap with the White Pass Study Area. Project effects would overlap in time with the effects of the White Pass expansion and cumulatively add to soil disturbance within the Upper Clear Fork Cowlitz watershed. Any decrease in soil productivity or increases in detrimental soil conditions from this project (i.e., immediately under any felled trees) would not be measurable at the 5th field watershed scale.
UCFC-4	Mt Rainier/Goat Rocks Scenic Viewpoint	Installation of fence posts will result in small (several square feet each) areas of soil disturbance in the short-term during construction. This project would not overlap in space with the White Pass expansion. Project effects would overlap in time with the effects of the White Pass expansion. The placement of fence posts will reduce soil productivity in the long-term, at the location of each fencepost. Any decrease in soil productivity or increases in detrimental soil conditions from this project (i.e., immediately under any felled trees) would not be measurable at the 5th field watershed scale. These effects will not be measurable at the site of 5th field scales.
UCFC-5	White Pass Wildfire	Approximately 204 acres of overstory and ground vegetation was consumed or killed by the wildfire. Although the event occurred in 1998, the effects temporally overlap with the White Pass expansion. The fire did not occur within the White Pass Study Area (i.e., no spatial overlap). Loss of vegetative cover/duff temporarily resulted in loss of soil productivity. Partial natural regeneration of the vegetation has occurred since the fire. With continued revegetation, the potential for long-term effects will be eliminated. In the long-term, the effects of the fire, coupled with the effects of the White Pass expansion and other project effects listed in this table, will contribute to a cumulative reduction in soil productivity at the 5th field watershed scale.
UCFC-6	Knuppenberg Lake Bridge Removal	Beneficial, long-term direct impact to soils occurred through the removal of 0.24 acre of impermeable surface associated with the bridge footings. Long-term project effects would temporally overlap with the White Pass expansion. Spatially, there is no overlap with the Study Area. Coupled with projects UCFC-12, UCFC-14 and UCFC-15, the removal of the bridge would improve soil productivity at the 5th field watershed scale. These projects will partially offset the cumulative effects to soils associated with the White Pass expansion.
UCFC-7	Wilderness Trail Maintenance	Approximately 20.5 miles of trail are maintained every other year, which would directly impact soils over the short-term through periodic soil displacement from treating sites along the corridor (i.e., removing downed logs and maintenance of drainage structures) with hand tools. A portion of this project would overlap spatially with the White Pass Study Area (i.e., PCNST in Hogback Basin). Temporally, the effects of annual maintenance work will overlap with the effects of the White Pass expansion. Maintenance would result in an increase in short-term detrimental soil condition along the trail, on a maximum of 7.5 acres. Over the long-term, treatment areas along the trail edge will naturally revegetate. Any increase in detrimental soil conditions from this project would not be measurable at the 5th field watershed scale.

Table 3.2-5:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Clear Fork Cowlitz Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UCFC-8	Ongoing Road Maintenance	Approximately 9 miles of road surface maintenance occurs every five years. Grading associated with road maintenance would directly impact soils over the short-term by creating erodible surfaces (detrimental soil conditions) along the edge of the road surface. This project would not overlap spatially with the White Pass Study Area. Ongoing maintenance activities in the 5th field watershed would overlap in time with the effects of the White Pass expansion, resulting in an increase in short-term detrimental soil conditions at the 5th field watershed scale on up to 46.3 acres. Regular maintenance and revegetation along the road prism will reduce the potential for long-term detrimental soil conditions. Any increase in detrimental soil conditions from this project would not be measurable at the 5th field watershed scale and would be offset by the long-term benefit of the maintenance.
UCFC-10	Clear Fork Trail Puncheon Installation	The installation of puncheon along 0.1 mile (0.07 acre) of braided trail (in a detrimental soil condition) directly affected soils by eliminating user trails and reducing the detrimental soil conditions. Spatially, this project did not overlap with the White Pass Study Area. Coupled with project UCFC-6, the puncheon would improve soil conditions at the 5th field watershed scale. These projects will partially offset the cumulative effects to soils associated with the White Pass expansion.
UCFC-11	Air Quality Monitoring Building	The creation of 0.02 acre of impervious surfaces for a building directly impacted soils over the long-term. Project effects would temporally and spatially overlap with the effects of the White Pass expansion. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil (i.e., loss of productivity) by the building addition.
UCFC-12	Rockfall Mitigation (between mileposts 143 and 149)	The mitigation of five areas of rock fall (approximately 2.5 acres total) directly impacted soils over the short-term by creating detrimental soil conditions until the slopes were stabilized. Spatially, this project did not overlap with the White Pass Study Area. Temporally, the short-term project effects contributed to a loss of soil productivity at the 5th field watershed scale. In the long- term, slope stabilization associated with this project and other slope stabilization/rockfall mitigation projects in this table will improve the detrimental soil condition in the 5th field watershed.
UCFC-14	Unstable Slope Repair Projects (between mileposts 145.61 and 145.77)	The repair of approximately 1 acre of unstable slopes will directly impact soils over the short-term, by creating detrimental soil conditions, until the slopes are stabilized. Spatially, this project will not overlap with the White Pass Study Area. Temporally, the short-term project effects will contribute to a loss of soil productivity at the 5th field watershed scale. In the long-term, slope stabilization associated with this project and other slope stabilization/rockfall mitigation projects in this table will improve the detrimental soil condition in the 5th field watershed.

Table 3.2-5:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Clear Fork Cowlitz Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UCFC-15	Unstable Slope Repair Projects (between mileposts 141.8 and 144.4)	Repair of unstable slopes on approximately 0.5 mile (4.5 acres) will directly impact soils over the short-term, by creating detrimental soil conditions, until the slopes are stabilized. Spatially, this project will not overlap with the White Pass Study Area. Temporally, the short-term project effects will contribute to a loss of soil productivity at the 5th field watershed scale. In the long-term, slope stabilization associated with this project and other slope stabilization/rockfall mitigation projects in this table will improve the detrimental soil condition in the 5th field watershed.
UCFC-16	Highway 12 Hazard Tree Removal	The periodic removal of occasional hazard trees within this 545-acre, 15-mile long corridor will directly impact soils. Hazard tree removal will spatially overlap with the White Pass Study Area and the 5th field watershed outside of the White Pass Study Area. Temporally, the effects of the hazard tree removal will overlap with the effects of the White Pass expansion. Short-term soil compaction (detrimental soil condition) will occur in areas immediately under and adjacent to the felled trees, where the use of heavy equipment is required. No long-term impacts to soils are expected.
UCFC-17	White Pass Ski Area Yurt Construction	Long-term, direct impact to soils resulted from approximately 0.01 acre of new impervious surfaces from construction of the yurt. Spatially, this project overlaps with the White Pass expansion. Temporally, the effects of the yurt will overlap with the effects of the White Pass expansion. In the long-term, this project contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil by impervious surface.
UCFC-20	Benton Rural Electric Association (REA) Power Line Maintenance	The periodic power line right-of-way maintenance within this 28-acre, 1-mile long corridor will directly impact soils. Power line maintenance will spatially overlap with the White Pass Study Area and the 5th field watershed outside of the White Pass Study Area. Temporally, the effects of the power line maintenance will overlap with the effects of the White Pass expansion. Short-term soil compaction (detrimental soil condition) will occur in areas immediately under and adjacent to fallen trees and where the use of heavy equipment is required for maintenance. No long-term impacts to soils are expected.
UCFC-21	White Pass Ski Area Day Lodge Remodel	Grading of 0.25 acre of previously disturbed ground resulted in short-term detrimental soil conditions. In addition, the lodge increased the impervious surface (loss of soil productivity) associated with the lodge by 0.05 acre. Temporally, the effects of the grading have been stabilized and do not overlap with the effects of the White Pass expansion. Spatially, the effect of the building construction overlaps with the effects of the White Pass expansion. In the long-term, the effects of the impervious surface, in conjunction with the other projects that include impervious surface, contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil.

As described in Table 3.2-5, numerous projects would contribute to a short-term increase in detrimental soil conditions within the White Pass Study Area.[24] The cumulative effects on detrimental soils from these projects are not expected to be measurable as project activities would be localized to specific areas within a larger management area and to varying timeframes within the short-term. The implementation of any Action Alternative would not increase detrimental soil conditions with the White Pass Study Area above the threshold of concern of 20 percent established by the Forest Plans. At the site scale, the maximum cumulative effects to detrimental soil conditions would occur over approximately 4.4 percent of the White Pass Study Area (refer to Table 3.2-6). Due to the spatial and temporal distribution of these projects, the cumulative effects are not projected to exceed any standards.

Similarly, within the 5th Field Upper Clear Fork Cowlitz watershed, detrimental soil conditions resulting from the projects described in Table 3.2-5 would not exceed the 20 percent threshold of concern for the entire watershed (refer to Table 3.2-6). The effect of detrimental soil conditions are not expected to be measurable at the 5th field scale. Cumulative impacts to soil productivity within the White Pass Study Area would result from implementation of any Action Alternative through the construction of impervious surfaces for buildings, lift terminals, and lift towers. Projects UCFC 11, 17, and 21, which overlap in the space and time with the White Pass expansion, would increase impervious surfaces by an additional 0.08 acre. Within the 5th Field Upper Clear Fork Cowlitz watershed, project UCFC 3a would add an additional 0.05 acre of impervious surface. Conversely, project UCFC 6 would remove 0.24 acre of impervious surface and restore soil productivity to this localized area. The cumulative effects of impervious surfaces (i.e., loss of soil productivity) are not expected to be measurable at the 5th Field as less than one percent of the watershed would be affected (refer to Table 3.2-6).

[24] Detrimental soil conditions discussed in the cumulative effects section assumes the worst-case scenario of soil impacts at the 5th field scale. Namely, that all soil impacts will result in detrimental soil conditions.

Table 3.2-6
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Clear Fork Cowlitz River Watershed on Geology and Soils

Impact Type	Alt. 1		Alt. 2		Mod. Alt. 4		Alt. 6		Alt. 9	
	Area (ac.)	Percent of Scale (%)	Area (ac.)	Percent of Scale (%)	Area (ac.)	Percent of Scale (%)	Area (ac.)	Percent of Scale (%)	Area (ac.)	Percent of Scale (%)
White Pass Study Area Scale										
White Pass Projects	17.50	1.56	37.30	3.33	49.14	4.39	28.97	2.59	27.57	2.46
Projects Not Associated with the White Pass Expansion	0.28	0.03	0.28	0.03	0.28	0.03	0.28	0.03	0.28	0.03
Cumulative Impacts	**17.78**	**1.59**	**37.58**	**3.36**	**49.42**	**4.42**	**29.25**	**2.61**	**27.85**	**2.49**
Fifth Field Scale										
White Pass Projects	17.50	0.02	37.30	0.05	49.14	0.07	28.97	0.04	27.57	0.04
Projects Not Associated with the White Pass Expansion	312.44	0.44	312.44	0.44	312.44	0.44	312.44	0.44	312.44	0.44
Cumulative Impacts	**329.94**	**0.47**	**349.74**	**0.49**	**361.58**	**0.51**	**341.41**	**0.48**	**340.01**	**0.48**

3.2.4.2 Upper Tieton River Watershed

A list of all projects occurring within the Upper Tieton watershed and the effect to geology and soil resources is presented in Table 3.2-7. For a description of each project, refer to Table 3.0-FEIS2.

Table 3.2-7:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Tieton Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UT-2	White Pass Ski Area Sewer Line Replacement	Approximately 0.73 acre of grading will occur, associated with the excavation of the trench and resulting in detrimental soil conditions in the short-term. Project implementation and effects are expected to overlap in time and space with the effects of the White Pass expansion. No long-term effects to soils are expected because the disturbed soil areas will be immediately stabilized after construction. Combined with other projects identified in this table, this project would add to an increase in short-term detrimental soil conditions within and outside the White Pass Study Area within the 5th field watershed.
UT-3	White Pass Ski Area Generator Shed and Propane Tank	The installation of 0.004 acre of impervious surfaces to build the shed and install the tank directly impacted soils over the long-term. Spatially the project effects occurred within the White Pass Study Area. The impervious surfaces and associated loss of productivity overlap temporally with the expansion. The increase in impervious surfaces will result in long-term lost soil productivity. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil.
UT-4	White Pass Ski Area Relocation of Chair 3 and Platter Lift	Approximately 0.5 acre of grading occurred for new lift towers and terminals, directly impacting soils and creating approximately 0.01 acre of impervious surface. Temporally, the grading impacts did not overlap with the White Pass expansion, but the impervious surfaces and associated loss of productivity overlap with the effects of the White Pass expansion. Spatially this project occurred within the White Pass Study Area. The grading increased short-term detrimental soil conditions but has since stabilized. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil (i.e., loss of productivity) by the lift towers and terminals.
UT-5	US Cellular Tower	The installation of 0.004 acre of impermeable surfaces (tower footing) to build a cell tower directly impacted soils (lost soil productivity) over the long-term. Spatially the effects of this project occurred within the White Pass Study Area. Temporally, the long-term loss of soil productivity will overlap with the effects of the White Pass expansion. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil (i.e., loss of productivity) by the cell tower footing.

Table 3.2-7:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Tieton Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UT-6	White Pass Ski Area Restaurant/Condo Conversion	A restaurant building that occupied 0.25 acre was demolished and a new building was constructed on the original building site, including additional sidewalks, resulting in an increase of 0.01 acre of impervious surface. Spatially and temporally, the effects of the building overlap with the effects of the White Pass expansion. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contribute to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil (i.e., loss of productivity) by the building and surrounding sidewalks.
UT-7	White Pass Ski Area Cross Country Yurt	Approximately 0.25 acre of grading took place in a previously disturbed area (parking lot) resulting in approximately 0.02 acre of new impervious surfaces from the yurt and infrastructure. Spatially, the effects of this project overlap with the effects of the White Pass expansion. Temporally, the effects of the yurt will overlap with the effects of the White Pass expansion. In the short-term, the disturbed soil has been stabilized and returned to use as a parking lot. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contribute to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil (i.e., loss of productivity) by the yurt and infrastructure.
UT-8	White Pass Ski Area Manager's Cabin	Approximately 0.25 acre of ground was cleared and graded resulting in short-term detrimental soil conditions. The construction of the cabin resulted in 0.04 acre of impervious surfaces. The graded areas have been stabilized. Spatially the effects of this project occurred within the White Pass Study Area. Temporally, the short-term detrimental soil conditions have been stabilized and therefore do not overlap with the effects of the White Pass expansion. The long-term loss of soil productivity will overlap with the effects of the White Pass expansion in the White Pass Study Area. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contribute to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil (i.e., loss of productivity) by the cabin.
UT-9	White Pass Ski Area Manager's Office	Approximately 0.25 acre of previously disturbed ground was graded, creating short-term direct impacts to soils. The creation of 0.03 acre of impervious surfaces directly impacted soils over the long-term. Spatially, the effects of this project occurred within the White Pass Study Area. Temporally, the short-term detrimental soil conditions have been stabilized and therefore do not overlap with the effects of the White Pass expansion. The long-term loss of soil productivity will overlap with the effects of the White Pass expansion in the White Pass Study Area. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contribute to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil (i.e., loss of productivity) by the manager's office.

Table 3.2-7:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Tieton Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UT-10	Dog Lake Campground/Four Trailhead Reconstruction	The reconstruction of the Dog Lake Campground and four trailheads directly impacted previously disturbed soils due to approximately 5 acres of grading, resulting in detrimental soil conditions, and removal of 1 acre of vegetation. This project does not overlap spatially with the White Pass Study Area. It is expected that the site will be stabilized immediately, but that the short-term effects will overlap with the effects of the White Pass expansion and other projects in this table that include detrimental soil conditions, as the site becomes revegetated and stable. No long-term effects are anticipated. The project includes traffic control and areas of revegetation which would aid in decreasing detrimental soil conditions that are currently present at the site.
UT-11	Clear Creek Overlook Reconstruction	The reconstruction of the Clear Creek Overlook will directly impact soils over the short-term due to approximately 1 acre of grading on previously disturbed soils. Creation of 0.1 acre of additional impervious surface will directly impact soils over the long-term. There is no spatial overlap with the White Pass Study Area. The short-term project effects associated with grading are expected to be stabilized immediately. Long-term project effects associated with the new impervious surfaces (i.e., lost soil productivity) will temporally overlap with the effects of the White Pass expansion. In the long-term, this project will contribute to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil by impervious surface.
UT-16	Trail 1106 Water Crossing	Re-construction or rerouting of the crossing (with hand tools) would likely result in a short-term increase in detrimental soil conditions on up to 0.1 acre. Any abandoned trail segment would be disguised and allowed to revegetate. This project does not overlap spatially with the White Pass Study Area. It is expected that the site will be stabilized immediately, but that the short-term effects will overlap with the effects of the White Pass expansion and other projects in this table that include detrimental soil conditions, as the site becomes revegetated and stable. No long-term effects are anticipated.
UT-18	Benton Rural Electric Association (REA) Power line Maintenance	The periodic power line right-of-way maintenance within this 223-acre, 8-mile long corridor will directly impact soils. Power line maintenance will spatially overlap with the White Pass Study Area and the 5th field watershed outside of the White Pass Study Area. Temporally, the effects of the power line maintenance will overlap with the effects of the White Pass expansion. Short-term soil compaction (detrimental soil condition) will occur in areas immediately under and adjacent to fallen trees and where the use of heavy equipment is required for maintenance. No long-term impacts to soils are expected.

Table 3.2-7:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Tieton Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UT-19	Highway 12 Hazard Tree Removal	The periodic removal of occasional hazard trees within this 509-acre, 14-mile long corridor will directly impact soils. Hazard tree removal will spatially overlap with the White Pass Study Area and the 5th field watershed outside of the White Pass Study Area. Temporally, the effects of the hazard tree removal will overlap with the effects of the White Pass expansion. Short-term soil compaction (detrimental soil condition) will occur in areas immediately under and adjacent to the felled trees, where the use of heavy equipment is required. No long-term impacts to soils are expected.
UT-20	Clear Lake Recreation Projects	Construction of the access road and other site improvements over approximately 2 acres would directly impact soils. Short-term detrimental soil conditions will occur during construction. Spatially this project occurs outside the White Pass Study Area. Temporally, the long-term loss of soil productivity associated with remaining impervious surfaces will overlap with the effects of the White Pass expansion. Combined with the other projects identified in this table, in the long-term, this project contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil by impervious surfaces.
UT-21	Fish Hawk/Spillway Campground Improvements	Construction of CXT toilet and access road directly impacted approximately 1 acre of soils. Short-term detrimental soil conditions occurred during construction, but the site has since stabilized, eliminating the short-term effects. Spatially this project occurred outside the White Pass Study Area. Temporally, the long-term loss of soil productivity associated with remaining impervious surfaces associated with the toilet (tens of square feet) will overlap with the effects of the White Pass expansion. Combined with the other projects identified in this table, in the long-term, this project contributed to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil by impervious surfaces.
UT-23	System Trail Maintenance	Approximately 48.5 miles of trail are maintained every other year, which would directly impact soils over the short-term through periodic soil displacement from treating sites along the corridor (i.e., removing downed logs and maintenance of drainage structures) with hand tools. A portion of this project would overlap spatially with the White Pass Study Area (i.e., PCNST at White Pass). Temporally, the effects of annual maintenance work will overlap with the effects of the White Pass expansion. Maintenance would result in an increase in short-term detrimental soil condition along the trail, on a maximum of 36 acres. Over the long-term, treatment areas along the trail edge will naturally revegetate. Any increase in detrimental soil conditions from this project would not be measurable at the 5th field watershed scale due to the dispersed nature of the soil impacts.

Table 3.2-7:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Tieton Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UT-24	Snoqueen Mine	Over the past decade, active operations have been confined to a limited season during the summer. Mining operations would result in short- and long-term impacts to soils due to grading, which is not stabilized (i.e., reclaimed). Spatially, the mine does not overlap with the White Pass Study Area. Temporally, the detrimental soils effects have overlapped and will continue to overlap in time. In the short- and long-term, the detrimental soil condition effects will overlap with the effects of the White Pass expansion and other projects in this table that include detrimental soil conditions.
UT-26	Highway 12 Rock Stabilization (at Mile Post 155)	The stabilization of 1 acre of unstable talus slopes will directly impact soils over the short-term by creating detrimental soil conditions until the slopes are stabilized. Spatially, this project does not overlap with the White Pass Study Area. Temporally, the short-term project effects will contribute to a loss of soil productivity at the 5th field watershed scale. In the long-term, slope stabilization associated with this project and other slope stabilization/rockfall mitigation projects in this table will improve the detrimental soil condition in the 5th field watershed.
UT-27	Highway 12 Rock Stabilization (at Mile Post 155)	The stabilization of 0.5 acre of unstable talus slopes in 2002 directly impacted soils over the short-term by creating detrimental soil conditions until the slopes were stabilized. Spatially, this project did not overlap with the White Pass Study Area. Temporally, the short-term project effects, contributed to a loss of soil productivity at the 5th field watershed scale. In the long-term, slope stabilization associated with this project and other slope stabilization/rockfall mitigation projects in this table will improve the detrimental soil condition in the 5th field watershed.
UT-28	Camp Prime Time Accessible Trail, Wagon Ride Route and Tree House	Construction of the trail, wagon ride route, and tree house will result in short-term detrimental soil conditions on up to 3 acres. Depending on the surfacing used for the trail, it could create additional impervious surfaces. Spatially, this project does not overlap with the White Pass Study Area. Temporally, the short-term detrimental soil conditions associated with the project are expected to overlap with the White Pass expansion. The long-term loss of soil productivity will overlap with the effects of the White Pass expansion in the White Pass Study Area. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contribute to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil (i.e., loss of productivity) by the impervious surfaces.
UT-29	Clear Lake Boat Launch Heavy Maintenance	Maintenance of the boat launch will result in short-term detrimental soil conditions on less than 1 acre during placement of more secure foundations for the access dock. Spatially, this project does not overlap with the White Pass Study Area. Temporally, the short-term detrimental soil conditions are expected to be immediately stabilized, and therefore not to overlap with the White Pass expansion. In the long-term, no impacts to soil productivity will occur as the site is on the lake bed.

Table 3.2-7:
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Tieton Watershed on Geology and Soils

Project Number	Project Name	Cumulative Effects
UT-31	Cellular Phone Carrier Improvements at White Pass Communication Site	The replacement of an existing cell tower and building addition will result in a short-term increase in detrimental soil conditions during construction on up to 0.3 acre and impervious surface of up to 0.1 acre. Spatially, this project overlaps with the White Pass Study Area. Temporally, the short-term detrimental soil conditions associated with the project will overlap with the White Pass expansion and other projects in this table that cause detrimental soil conditions. The long-term loss of soil productivity will overlap with the effects of the White Pass expansion in the White Pass Study Area. In the long-term, this project and the other projects resulting in impervious surfaces, listed in this table, contribute to a cumulative reduction in soil productivity at the 5th field watershed scale due to the displacement of soil (i.e., loss of productivity) by the impervious surfaces.
UT-32	Camp Site Maintenance	The periodic removal of occasional hazard trees will directly impact soils. Hazard tree removal will spatially overlap with the White Pass Study Area and the 5th field watershed outside of the White Pass Study Area. Temporally, the effects of the hazard tree removal will overlap with the effects of the White Pass expansion. Short-term soil compaction (detrimental soil condition) will occur in areas immediately under the felled trees. No long-term impacts to soils are expected from hazard tree removal. Other maintenance activities are not expected to result in effects to soils.
UT-34	Unstable Slope Repair Projects (between Mile Posts 156.32 and 156.56)	The stabilization of approximately 4 acres of unstable talus slopes directly impacted soils over the short-term by creating detrimental soil conditions until the slopes were stabilized. Spatially, this project did not overlap with the White Pass Study Area. Temporally, the short-term project effects contributed to a loss of soil productivity at the 5th field watershed scale. In the long- term, slope stabilization associated with this project and other slope stabilization/rockfall mitigation projects in this table will improve the detrimental soil condition in the 5th field watershed.
UT-35	Unstable Slope Repair Projects (between Mile Posts 161.93 and 165.02)	The stabilization of approximately 0.53 acre of unstable talus slopes directly impacted soils over the short-term by creating detrimental soil conditions until the slopes were stabilized. Spatially, this project did not overlap with the White Pass Study Area. Temporally, the short-term project effects contributed to a loss of soil productivity at the 5th field watershed scale. In the long-term, slope stabilization associated with this project and other slope stabilization/rockfall mitigation projects in this table will improve the detrimental soil condition in the 5th field watershed.

As described in Table 3.2-7, several projects would contribute to a short-term increase in detrimental soil conditions with the White Pass Study Area. The cumulative effects on detrimental soils from these projects are not expected to be measurable as project activities would be localized to specific areas within a larger management area and to varying timeframes within the short-term. The implementation of any Action Alternative would not increase detrimental soil conditions with the White Pass Study Area above the threshold of concern of 20 percent established by the Forest Plans. Within the site scale, the maximum

cumulative effects to detrimental soil conditions would occur over approximately 13.5 percent of the White Pass Study Area (refer to Table 3.2-8). As a result of the special and temporal distribution of the projects, the cumulative effects are not expected to be measurable.

Similarly, within the 5th Field Upper Tieton River watershed, detrimental soil conditions resulting from the projects described in Table 3.2-5 would not exceed the 20 percent threshold of concern for the entire watershed (refer to Table 3.2-7). The effect of detrimental soil conditions is not expected to be measurable at the 5th field scale. Cumulative impacts to soil productivity within the White Pass Study Area would result from implementation of any Action Alternative through the construction of impervious surfaces for building, lift terminals, and lift towers. Projects UT - 3, 4, 5, 6, 7, 8, 9 and 31, which overlap in the space and time with the White Pass expansion, would increase impervious surfaces by an additional 0.2 acre within the site scale. This represents a maximum area of impact of approximately 13.5 percent of the site scale. Within the 5th Field Upper Tieton River watershed, project UT 11 would add an additional 0.1 acre of impervious surface. The cumulative effects of impervious surfaces (i.e., loss of soil productivity) are not expected to be measurable at the 5th Field as less than one percent of the watershed would be affected (refer to Table 3.2-8).

Table 3.2-8
Cumulative Effects of Past, Present, and Reasonably Foreseeable Projects in the Upper Tieton River Watershed on Geology and Soils

Impact Type	Alt. 1		Alt. 2		Mod. Alt. 4		Alt. 6		Alt. 9	
	Area (ac.)	Percent of Scale (%)	Area (ac.)	Percent of Scale (%)	Area (ac.)	Percent of Scale (%)	Area (ac.)	Percent of Scale (%)	Area (ac.)	Percent of Scale (%)
White Pass Study Area Scale										
White Pass Projects	18.40	4.08	18.40	4.08	31.16	6.91	22.19	4.92	47.23	10.47
Projects Not Associated with the White Pass Expansion	13.54	3.00	13.54	3.00	13.54	3.00	13.54	3.00	13.54	3.00
Cumulative Impacts	**31.94**	**7.08**	**31.94**	**7.08**	**44.70**	**9.91**	**35.73**	**7.93**	**60.77**	**13.48**
Fifth Field Scale										
White Pass Projects	18.40	0.02	18.40	0.02	31.16	0.03	22.19	0.02	47.23	0.04
Projects Not Associated with the White Pass Expansion	314.17	0.27	314.17	0.27	314.17	0.27	314.17	0.27	314.17	0.27
Cumulative Impacts	**332.57**	**0.28**	**332.57**	**0.28**	**345.33**	**0.29**	**336.36**	**0.28**	**361.40**	**0.31**