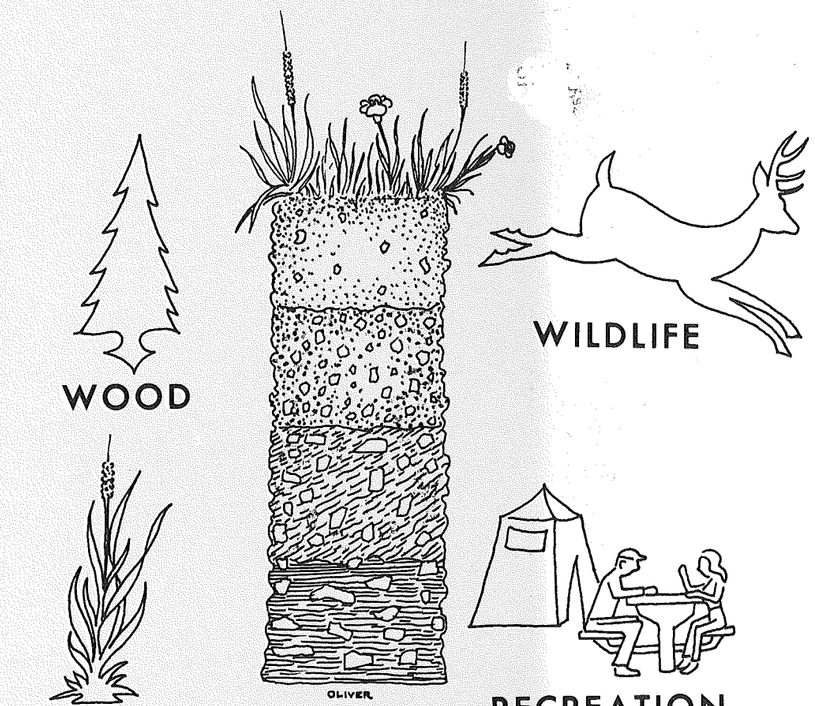
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SOIL RESOURCE

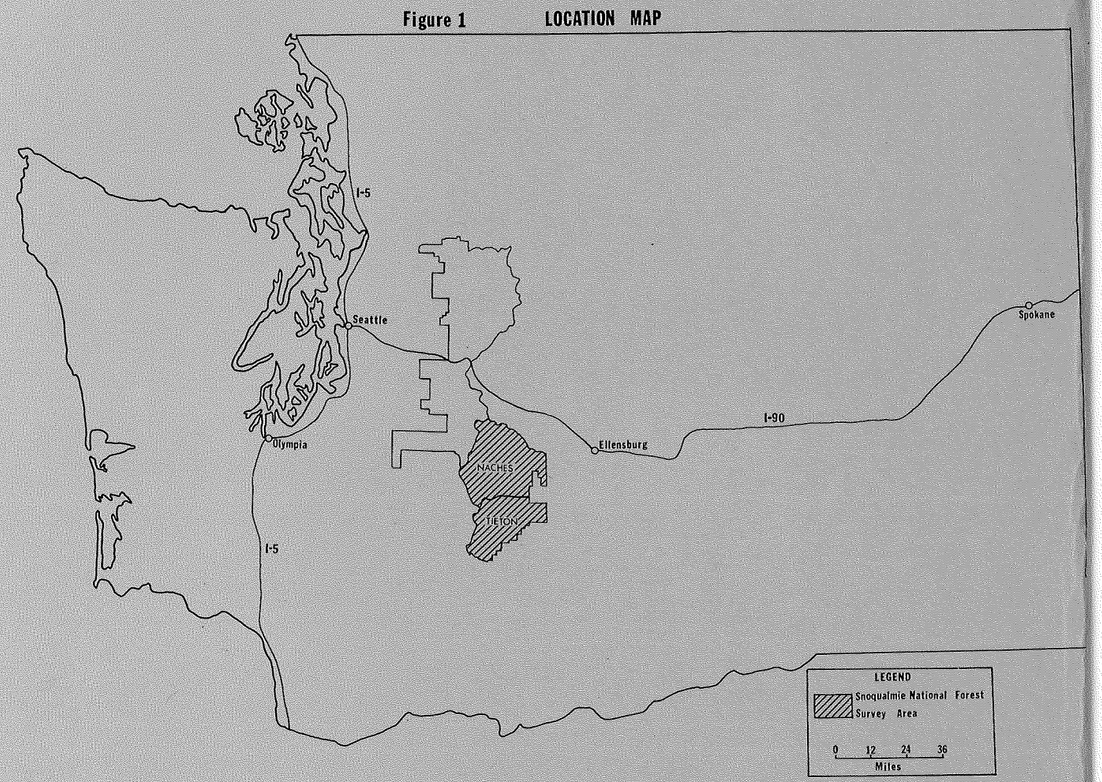
SNOQUALMIE NATIONAL FOREST
EASTSIDE



FOREST SERVICE

PACIFIC NORTHWEST REGION

Figure 1. Location Map



This project covers the Naches and Tieton Ranger Districts of the Snoqualmie National Forest and includes both Forest and other lands within the general Forest boundary. The total area mapped is approximately 571,000 acres. Of this, approximately 38,500 acres are privately- and State-owned lands. Counties within the mapping area are Yakima and Kittitas.

Naches and Tieton Ranger Districts

SOIL RESOURCE INVENTORY

SNOQUALMIE NATIONAL FOREST

Pacific Northwest Region

April 15, 1973

Prepared by

Robert V. Snyder and John M. Wade

Soil Scientists

PREFACE

This Soil Resource Inventory of the eastside portion of the Snoqualmie National Forest was made to provide some basic soil, bedrock and landform information for management interpretations. The inventory is part of the Regional soils program developed by the Soil Management Branch of the Division of Watershed Management to assist forest land managers in applying multiple use principles.

The objective of this Soil Resource Inventory is to provide soils information in a form useful to the land manager as an aid to multiple use management as directed by Public Law 86-517. This law states that the National Forests are to be administered to achieve and maintain in perpetuity a high level of annual or regular periodic output of the various renewable resources of the National Forests without impairment of the productivity of the land.

All renewable surface resources of the National Forest are dependent upon soil, which is a nonrenewable resource. Soil develops at a very slow rate, about one inch every thousand years. This fact necessitates conservation, wise use, and in many instances, preservation of this basic resource in order to produce high-level sustained yields of water, timber, recreation, wildlife, and forage. To accomplish sustained yield of renewable resources, to conserve or preserve the soil resource while making wise use of this resource, it is necessary to have basic soils information and to make sound management interpretations.

This report contains information on climate, soils, geology, vegetation, landform features, and some management interpretations. Under separate cover is an Atlas of soil maps showing location and extent of the various soils, Tables of Management Interpretations, Table of Soil Characteristics of Modal Site, Table of Some Mapping Unit Characteristics, Features and Qualities; Table of Bedrock Characteristics, and Table of Water-Holding Capacities.

Field mapping was conducted from July through October 1970 by Soil Scientists Robert V. Snyder, John M. Wade and Raymond Lavine. Supervision was provided by Loren D. Herman.

During the course of the study, valuable assistance, advice and cooperation received from Forest personnel was sincerely appreciated.

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USE

Land management activities generally relate to the soil resource. Timber harvest, road construction, recreation development, and many other activities have an effect on the soil resource to some degree. It is extremely important for the land manager to thoroughly understand the effect of the various activities on the soil. It is equally important for the land manager to fully understand the capabilities of the soil resource. Basic soils information contained in this report will help the land managers and planners to (1) determine the effects of management on the soil and water resource, and (2) evaluate the capabilities of the soil for its best use.

The information in this report is presented in two levels. The first is the Mapping Unit level and is the basic level of soil identification and management interpretation used in the report. The mapping unit is derived and defined on the basis of its soil, landform, geology, and vegetation characteristics. The average delineation size is 50 to 600 acres.

At this level, management problems related to the landform and soil are easily defined and interpretations have been made. This information has been tabulated and can be found within the Appendix of this report, or in the Atlas along with the soil maps.

The second level of presentation is the generalized land areas and is a broader level than just described. The land areas each contain several mapping units that have similar soil and topographic characteristics. Certain management problems and uses of these mapping units are similar and are discussed as a group. The land areas then enable the user to become quickly familiar with general problems occurring throughout large areas.

The Soil Resource Inventory (SRI) has its primary use at the planning level. Soils, landforms, and bedrock characteristics are defined at an intensity sufficient to help develop resource management policies and basic plans. Due to the reconnaissance nature of this survey, it lacks detail for use in high-intensity, small-area projects. These projects require additional onsite study by various technical specialists, including soil scientists.

There are many uses for the information in this report. Some are quite simple and apparent, while others have not yet been conceived. The real work lies ahead in effectively and fully using this information. The use of this information is achieved best by those with full understanding of the interrelationships of the basic earth features.

Examples of how SRI information can be used are listed below:

1. Transportation Planning - This is an area where the soils information has key application. Conditions and problems can be met or avoided

based on information such as landscape stability, soil depth, soil drainage and/or bedrock type and competency. Roads may be selected that avoid unstable areas, and construction and maintenance costs may be more accurately estimated. Sources of road rock may also be located through use of soil maps. SRI information is available for assistance in road design such as cutbank ratios and road rock thickness.

2. Recreation Planning - The SRI information indicates the various soil suitabilities and limitations that may apply to ski areas, camping areas, trails, roads, and other aspects of recreation development. By knowing the soil suitabilities and limitations, the planner is better able to make plans that are consistent with the best use of the land.

3. Multiple Use Plans - The soils information in this report should be incorporated into the multiple use plans. As an example of application, the soil areas in this report can provide a map to show the critical soil areas and their associated problems. These problems are discussed for individual soils and land areas. This is the kind of information that will support the policy and directives, and assist in multiple use. Another example of use would be to color the maps in the Atlas to illustrate various soil management relationships. For instance, the maps can be colored to show stability, erosion, site index, etc.

4. 5-Year Action Plan - This report provides information on the relative susceptibility of soil and other resource damage from timber harvest, road construction, and other timber-related activities. Provided also, is information on regeneration problems and erosion control requirements.

5. Timber Management Plan - The soils information can suggest direction and support policy for allowable cut determinations, logging systems, slash disposal methods, operating season, and deferred cutting areas. With a better understanding of problems and their location, the cut can be planned so that at a given time the majority of cutting is not taking place in critical areas. By spreading out and deferring the more critical areas, more time is available for proper road location and design on these areas. Also, within a few years, logging technology may have developed so that harvest methods are compatible with critical soil areas without causing excessive soil and resource damage.

6. Impact Reports - Any report involving the impact of a management activity requires soils input. Whether it is a ski area, recreation, or damsite proposal, there are soil factors that must be considered to make the report complete.

7. Land Appraisal and Exchange - Soils information should be used for land appraisal and exchange activities. The value of the land is related to such soil factors as texture, depth, drainage, productivity, and stability. Without knowledge of these and other soil factors, how can land value be appraised?

8. Multiple Use Survey Reports - Any MUS study can find the basic soils data in the SRI. However, additional interpretations may be needed for more specific information concerning soils and their behavior.

9. The following is a list of more specific uses of the report. These uses are adaptable and compatible with the survey data and are well within the scope and intensity of the survey:

   a. Engineering Testing - By using the soil maps, more efficient testing can be done. The soil maps can be used to determine which soils are most susceptible to certain engineering problems. These problem soils may need more closely spaced testing than soils in which few problems are anticipated.

   b. Reservoir Sites - This report gives information that can be used to determine problems that may be encountered for a reservoir site. The soil interpretations will enable the planner to better determine the general suitability of a particular site and the soil stability as they affect reservoir uses.

   c. Hydrologic Analysis - The information in the SRI is sufficient to determine a broad hydrologic analysis and water balance on the Forest, and as a basis for comparisons between larger watersheds.

   d. Multiple Discipline Teams - Under the concept of MDT, where a number of specialists coordinate on a management problem through team effort, the soils report will supply essential background information. It will give the team basic soils information on the uses, limitations, and hazards of soils as they relate to resource management.

   e. Timber Harvest Methods - Additional facts known about the potential for erosion and landscape stability will encourage selection of timber harvest methods that cause minimum damage to soil and other resources.

   f. Timber Harvest and Road Construction Operating Season - These activities should be scheduled at times when they will cause minimum soil damage. Many soils are subject to damage (compaction, erosion, site deterioration) by timber harvest activities when overly wet or excessively dry.

   g. Erosion Control - Since there is wide variability in soil texture, depth, structure, permeability, drainage, and topography, wide differences also occur in the ability of the soil to resist erosion. Forest soils are rated as to their potential erosion class. The land manager can use this information to determine which areas will need special erosion protective measures. These will need to be developed on a site-by-site basis.

   h. Recreation Developments - Several kinds of information are available in this report to assist in selecting favorable sites for campground development. Among these are soil and landform properties and characteristics, specific ratings of filter drainage field suitability, the relative resistance of soil and vegetation to site deterioration, and indications of special problems which may be encountered.

LAND AREAS

Many mapping units are related in that they contain broadly similar soils, bedrock, landforms, and vegetative characteristics; and, therefore, have similar gross management problems. Those mapping units with management similarities have been combined into broad areas called "Land Areas." These areas are defined and given a name that identifies their general soil and landform characteristics. Soil and bedrock characteristics, important soil limitations and interpretations, and the relative impact on soil and water resources from various management activities are discussed for each area.

The land areas provide an easy-to-use, broad overall view of the survey area. The user can readily determine what broad areas have common problems. The land areas can provide broad answers and guidelines to the following question: What and where are the major soil problem areas and what general kinds of management practices should be followed to be consistent with good land management under the multiple use concept?

It is important to understand that while the soils within each area have problems in common, the severity of a particular problem may vary within each area. Also, because of the broad nature of the area, there will be some soils present that may not conform to the definition of that area. Generally though, at least 70 percent of an area will consist of mapping units defined for the area.

The land areas provide only the "broad view." They are a starting place for identifying broad problems. From there, the user should refer to the basic mapping units found in the Atlas. Then, for more specific information on soil properties and interpretations for each mapping unit, refer to the Soil Report for the "Descriptions of Mapping Units", and to the Atlas for the appropriate tables. Management recommendations for detailed projects need onsite evaluations.

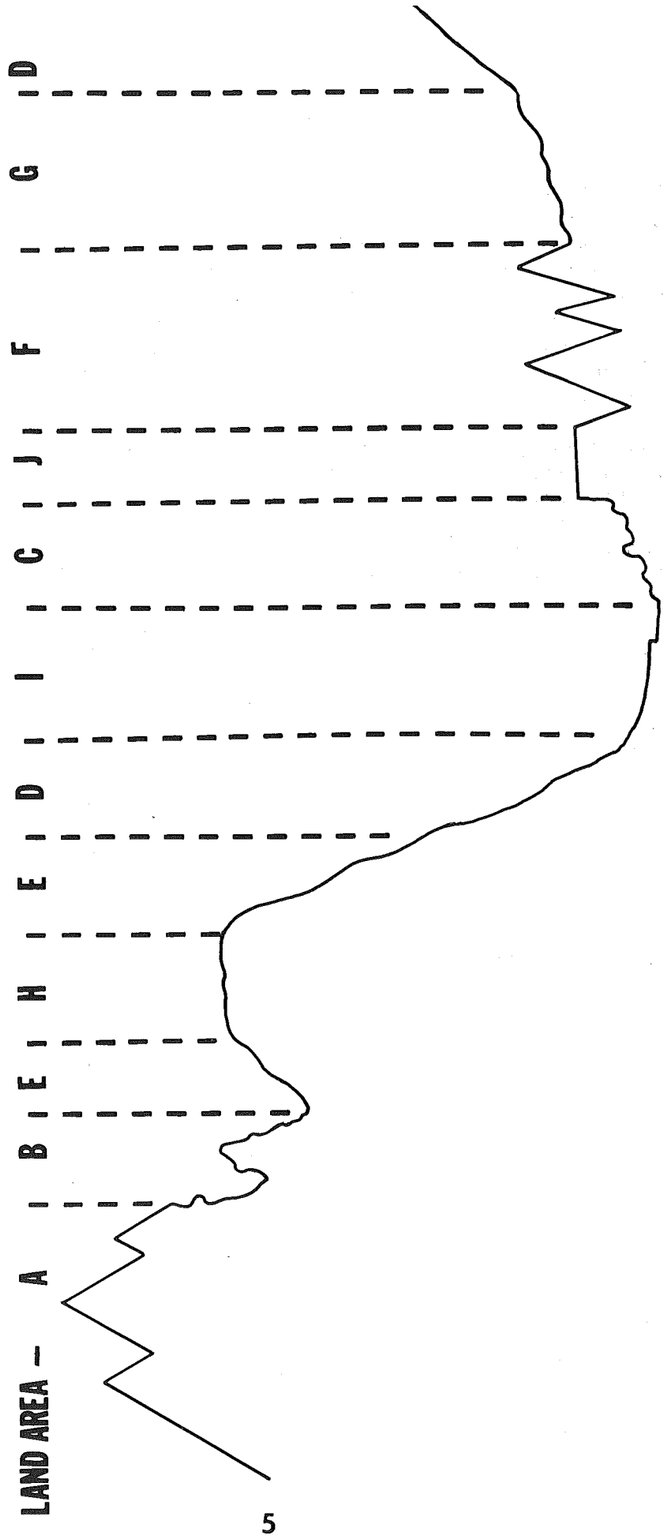


Figure 2

LAND AREA A

Shallow Soils on Very Rugged and Rocky High-Elevation Miscellaneous Lands

Land Area A consists primarily of shallow soils, rock outcrop, talus slopes, meadows, and includes some perpetual snow and ice. The area occurs extensively along the Cascade Crest and in the vicinity of Mount Aix.

Approximately 60 percent of this land area occurs above 6,000 feet where alpine characteristics are the dominant features. Rock outcrops and talus slopes are major features of that part of the area occurring below 6,000 feet.

Much of Land Area A is in the Alpine Resource Zone although major areas of rock outcrop and talus slopes occur in the Upper and Principal Forest Resource Zones. The trees that occur in the Alpine Resource Zone are generally scattered on the lower slopes of the zone and consist primarily of subalpine fir, whitebark pine, mountain hemlock, and some Engelmann spruce.

Landform

The topography consists of rugged and rocky high-elevation ridges and mountains. Small glacial lakes and basins, meadows, talus slopes, rock outcrop and permanent snow and ice are common features. Slopes range from nearly level on some of the meadows and ridgetops to nearly vertical on many of the sideslopes. The steep sideslopes are frequently highly dissected and contain numerous rock outcrops, talus runs, and avalanche tracks. The meadows may occur on ridgetops, on saddles, or in the bottoms of small glacial basins.

Mapping Units

The mapping units on this area are 1, 6, 50, 60, 70, 80, 90, 505, 605 and 805.

Mapping Unit 1 - Contains a mixture of low-site timber and meadowlands.

Mapping Unit 6 - Contains rock outcrops, talus slopes, meadows, and snow and ice.

Mapping Units 50, 60, 70, 80 and 90 - Consist of rock outcrop.

Mapping Units 505, 605 and 805 - Consist primarily of rock outcrop and talus slopes.

Soils

Soils, when present, are characteristically shallow (1 to 3 feet in depth) gravelly and stony sandy loams or loams. Volcanic ash may be incorporated in the surface 2 to 4 inches. These soils are generally well drained except in some meadows where drainage may be restricted by compact subsoils or unfractured bedrock.

Bedrock

The bedrock of this area is variable. It includes andesite, basalt, pyroclastics, sedimentaries or granitics. These rocks are hard and competent throughout much of the area. However, rocks of only moderate hardness and competence occur locally, especially in areas where pyroclastic or sedimentary rocks dominate.



Figure 3. View of Land Area A

The upper half of this picture shows the rock outcropping, talus slopes, and alpine meadows that are characteristic of Land Area A.

Some Important Soil Limitations and Interpretations

This area has the following important limitations and interpretations:

Watershed

1. Severe Erosion Potential - The scattered soils which do occur in this land area are very fragile. Surface soils lack the soil structure necessary to resist erosional forces. Location and position subject these soils to erosional forces of heavy precipitation, snowmelt, freeze and thaw, and high winds. The erosion potential increases with slope and becomes very severe on steeper slopes. A factor that greatly increases the erosion potential locally is the presence of rock outcrops or barren rock slopes located upslope of soils. Rainwater or snowmelt rapidly runs off these slopes and flows onto downslope soils at high velocity. This can cause very severe erosion unless the soils have a protective vegetative cover.

The erosion potential in this area is greatly increased whenever the vegetation is destroyed and the surface soils become exposed to raindrop impact, runoff, and winds. Vegetation generally consists of grasses, sedges and small bushes that have a relatively low tolerance to trampling and over-grazing. Once destroyed, the vegetation in this area is often very slow to return because of the very short growing season and cold soils. This allows erosion to continue for extended periods, causing damage to both soils and aesthetics.

2. Limitations to Vegetative Growth

The soils in this area are very limited in their ability to support vegetative growth. Soils are shallow and contain a high percentage of gravel and stones. This limits the soil nutrient and moisture-holding characteristics. Restrictions to growth occur throughout most of the year. During the winter and much of the spring and fall the soil temperatures are below that required for biotic and chemical activities needed for plant growth. Further restrictions to growth often occur during late summer and early fall due to moisture stress. Warm, sunny days, especially when accompanied by desiccating winds, rapidly depletes the soil moisture. These factors result in a very short growing season, limited soil moisture conditions, and relatively infertile soils. They are major limitations to all vegetative growth. They limit the types of vegetation that will grow and cause restrictions in time when vegetation planting or seeding will be most effective.

3. Erosion Control - Erosion control through seeding of standardized grass mixtures often has little chance of success in this area. This is because of the severe soil limitations to vegetative growth that are especially incompatible to lower-elevation grass species.

   In order for grass seeding to be successful, it is imperative that the grass species be compatible with the harsh soil and climatic conditions that exist. The greatest chance of success could be expected with transplanting of native vegetative species when the soil is at its optimum condition. This occurs when the soil temperatures are warm enough to promote chemical and biotic activity, and the soil contains its highest level of moisture. Highest moisture levels occur in the spring shortly after spring snowmelt and soil temperatures begin warming up at this time.

Engineering

Road Construction - This land area generally occurs above the commercial timber zone, therefore requiring few, if any, roads for timber access. However, some roads may be constructed for other purposes such as for recreational use.

Severe topographic conditions cause road construction problems on much of this area. The slopes are frequently very steep and dissected, and contain numerous rock outcrops, talus runs, and

avalanche tracks. Roads frequently have poor alignment and often require blasting during excavation resulting in expensive construction. High annual maintenance costs can be expected in the rugged areas where rockfall, debris slides and avalanches occur periodically.

Selected Soil and Water Impacts from Various Management Practices

Impacts to soil and water in this area generally occur from recreational use and engineering practices. Common impacts are evaluated as follows:

1. Engineering Practices

Roads frequently have a severe impact on the soils and aesthetics in this area. Topographic features are such that excavation waste (or rock material from blasting) often moves downslope considerable distance, causing raw scars and exposed soils. These scars are not only unsightly, but continue to ravel, slough, and erode, causing soil damage and contributing to stream sedimentation.

A major impact of roads in this area is aesthetic damage. This area is picturesque and is generally devoid of timber which allows roads to be easily visible. Wasteslopes and high cutbanks along these roads are often visible for long distances and impose a very strong impact on aesthetics. This impact is of long duration because of serious soil and climatic limitations to vegetative growth. Exposed soils on cutbanks and wasteslopes are generally very difficult (if not impossible) to revegetate and require intensive treatment to minimize the problems of soil erosion and aesthetic damage.

2. Recreational Use

Recreational use in this area can have damaging soil impacts. Two of the common recreation uses are evaluated as follows:

a. Trails and Trail Use - Trails in this area are subject to severe erosional damage. Heavy foot traffic or a moderate to heavy volume of horse and/or motor scooter traffic can cause considerable soil disturbance by soil loosening and displacement. These disturbed soils are then easily eroded by water that may accumulate and run over the trail surface.

Certain kinds of practices have been observed to minimize trail erosion damage. Two of these are as follows:

(1) Trails which are outsloped or water-barred have lower erosional rates because water is not allowed to accumulate.

(2) Surfacing of heavily-used trails and trailheads provides positive erosion protection.

b. Trampling and Grazing Damage to Vegetation - The vegetation in this area generally consists of grasses, sedges and small shrubs that have a low resistance to trampling by foot or horse traffic, or over-grazing by recreational livestock. Once destroyed, soils are exposed to erosion causing losses to both soils and aesthetics. These effects are often long-lasting as vegetation is generally slow to return. This is because the cold soils and short growing season in the area impose severe limitations to vegetative establishment and growth. Because of these problems it is imperative that the present vegetative cover be maintained and extra precautions taken in heavy-use areas. Locations around trailheads, popular campsites and around the edges of alpine lakes are apt to receive the heaviest trampling and/or grazing.

Certain practices have been observed to minimize trampling and over-grazing. Two of these are as follows:

(1) Surfacing of trails in areas of heavy use, such as trailheads and around lake edges, may encourage traffic to remain on the trails. Surfacing also protects the trails from erosional damage.

(2) The rotation of heavily-used campgrounds would allow the vegetation a period in which to rejuvenate.

LAND AREA B

Shallow Soils on Very Steep, Rugged, and Often Highly-Dissected, Rocky Midslopes and Upper Sideslopes

This area consists of shallow soils on very steep, rocky and rugged sideslopes that occur in numerous locations throughout the inventory area. Approximately 85 percent of this land area is between 3,000- and 7,000-feet elevation with the remaining 15 percent occurring on steep, rocky topography below this elevation range.

Land Area B is primarily in the Upper Forest Resourze Zone although some does occur in the Principal Forest Resource Zone. The timber generally consists of true fir, mountain hemlock, and western larch with some Douglas-fir and ponderosa pine occurring at lower elevations. Timber most often occurs in small stands or stringers between rock outcrops, drainages, narrow talus slopes and/or avalanche tracks. Douglas-fir site is generally Site Class V where it occurs.

Landform

The topography consists of very steep midslopes and upper slopes, ranging from 35- to over 100-percent slopes. These sideslopes contain numerous rock outcrops and are frequently highly dissected with closely-spaced parallel stream patterns and/or narrow talus slopes. Avalanche tracks or debris slide tracks may also be present.

Mapping Units

The mapping units on this area are 7, 8, 54, 55, 554, 555, 720, 883 and 992. Small area of mapping units 552, 553, 661, 662, 663, 881, 882 and 991 occur as common inclusions.

Soils

The soils in this area often occur intermittently (about 50 percent) and are closely associated with rock outcrops, stream channels, narrow talus slopes, avalanche tracks and/or debris slide tracks. The soils are characteristically shallow, well drained, gravelly and stony loams and sandy loams.

Bedrock

The bedrock of this area is variable and may be andesite, pyroclastic, sedimentary or granitic. These rocks are generally hard and competent throughout most of the area. However, rocks of only moderate hardness and competence occur locally.



Figure 4. View of Land Area B

The background shows the steep and rugged higher-elevation sideslopes that are characteristic of Land Area B. The timber occurs closely associated with rock outcrops, talus runs, stream dissections and/or avalanche tracks. In this photo, Land Area A occurs above timberline across the tops of the ridges.

Some Important Soil Limitations and Interpretations

This area has the following important limitations and interpretations:

Watershed

Severe Erosion Potential - This land area has a severe erosion potential. This is due to the kind of soils present and the topographic characteristics and climate. The soils are fragile, weakly structured and offer little resistance to raindrop impact and dispersion when their protective vegetative cover and duff layers are removed. Vegetation and duff removal by management activities such as log skidding, slash disposal and road construction, results in soil exposure in harvest units and on road cutbanks, wasteslopes and fills. Once soils are exposed on these steep slopes, raindrop impact and rapid runoff from heavy rains or melting snow can provide running water of sufficient force to cause extensive erosion.

A factor that greatly increases the erosion potential locally is the presence of rock outcrops or barren rock slopes located upslope of soils. Rainwater or snowmelt rapidly runs off these slopes and flows onto downslope soils at high velocity. This can cause very severe erosion unless the soils have protective vegetative cover.

The occurrence of snow avalanches can be a very severe agent of erosion on many of the higher-elevation portions of this area. Many of these locations exhibit numerous indications of previous avalanche activity and the potential for future avalanche activity may be increased by timber removal. Once timber is removed, the anchoring effect by trees becomes lost and patterns of snowfall accumulation and melt rate are altered. Avalanches may occur that remove the soil materials, resulting in a denuded slope with adversely changed hydrologic characteristics.

Tree removal on these slopes may increase the frequency of debris slides. Tree root deterioration reduces both soil anchoring and water removal through transpiration. During periods of heavy rainfall or rap snowmelt, the soils become saturated and may be unable to resist slidin

Engineering

Topographic Problems Affecting Road Construction - Road construction is difficult because of the steep, rugged and dissected landforms with their associated rock outcrops, talus slopes and occasional avalanche tracks. Road construction across these landforms is relatively expensive (both in construction and maintenance), and many of the previously constructed roads on these areas have resulted in high damage to soils and other resources. Much of this damage has resulted from the instability of sidecast waste material that continually ravels, sloughs and erodes. The sidecast areas are very difficult to revegetate and require extensive erosion control measures.

Timber Management

1. Topographic Problems Affecting Timber Harvest - Tree breakage may be considerable because of the steep, rugged and rocky topography. Breakage may be caused by trees striking rocks when they fall or rolling down the steep, rocky slopes for some distance after falling.

2. Limitations to Regeneration and Tree Growth - The soils in much of this area have limited capacity to support vegetative growth. Limitations are caused by both soil and climatic factors. During much of the year at higher elevations, the soils are cold and have temperatures below that required for growth. Additional limitations are caused by the fact that soils are often relatively shallow and contain a high per centage of gravel and stones. This limits the soil's nutrient status and its ability to retain sufficient moisture throughout the growing season.

   In the eastern portion, at both higher and lower elevations, the major limitations are caused by a combination of low annual precipitation, low soil moisture-holding capacity, and hot summer soil temperatures. These factors cause severe moisture stress throughout much of the growing season.

   These are major limitations to all tree and plant growth, but are more limiting to some tree species than others. Often the most prevale

natural species in any given area has adapted best to existing soil and climatic conditions and can be expected to afford the best success when used as a regeneration species. Also, the factors discussed cause restrictions in time of planting. The best success can be expected when soil moisture and temperature conditions are satisfactory for growth. This usually occurs some time after the spring snowmelt.

Selected Soil and Water Impacts from Various Management Practices

There are different ways in which various practices will have an impact on the soil. Some of the common practices and their impacts on soils are evaluated as follows:

1. Timber Harvest Methods

   a. Tractor - Impact on soils from tractor operation is likely to be very severe. Damage is caused by removing the duff, loosening soils and causing soil displacement. Raindrop impact on the exposed soils, along with water accumulating and running over the surface, is likely to cause severe erosion. Also, the safety factor should be considered on these steep slopes where there is a high potential for tractor capsize. Downhill speed control and tractor stability may require running with the blade implanted in the soils. This causes additional soil disturbance that would likely be followed by severe erosion.

   b. Partially Suspended Cable System - The impact to soils is likely to be severe over much of the harvest area due to topographic features. (See "Common Soil Problems.") Much of the total damage caused on these soils is related to the roads. Roads may cause considerable soil exposure on cutslopes and wasteslopes that are subject to erosional losses. Soils that are damaged, whether on roads or in harvest units, are often difficult to revegetate due to the poor success of grass seeding. This allows exposed soils to be subjected to erosional losses for extended periods.

   c. Fully Suspended Cable System - The impact on soils is minimal from the actual harvest operation. Only occasional small local areas would be expected to incur duff damage during harvest and as long as the duff is intact, there is little chance for erosion to occur. However, considerable damage may be incurred from road construction and would depend upon the same considerations as previously discussed.

   d. Aerial Logging - The impact on soils is very minimal. Some slight duff destruction and displacement could be expected locally from the impact of felling. However, the general absence of skidding and roads removes the primary causes of soil disturbance.

2. Engineering Practices

Roads frequently have a severe impact on the soils in the area. Topographic features of this land area are such that sidecast excavation waste often moves downslope a considerable distance, leaving raw scars and exposed soil. These scars are not only unsightly, but continue to ravel, slough, erode, and contribute to sedimentation. They are generally very difficult to revegetate and require intensive treatment to minimize the problems.

Further revegetation difficulties are created by excessive road cuts. Due to the shallowness of the soils, the majority of the cuts are in bedrock material. Large cutbanks are exposed that consist primarily of bedrock and have little chance of supporting any type of vegetation.

Cutslopes and wasteslopes create raw scars on the landscape that because of high topographic position are often easily visible for long distances. This causes high impact to aesthetic values.

LAND AREA C

Moderately Deep to Very Deep, Unstable Soils on Dissected Midslopes and Toeslopes; Landslides and Landflows.

This area consists of unstable soils over highly weathered, soft, unstable bedrock. Much of this area does not cover large continual acreages but occurs scattered throughout the inventory area. 1/ A few of the larger active landslide areas occur in the following locations: (1) southeast of the Tieton Reservoir, (2) at the upper end of the Milk Creek drainage; (3) south of the American River and Bumping River junction, and (4) at a few locations on the Crow Creek Drainage. The majority of the land area occurs between 3,000- and 6,000-feet elevation.

Land Area C is primarily in the Principal and Upper Forest Resource Zones. The timber generally consists of true fir, western redcedar, Douglas-fir and white fir, with some occurrence of ponderosa pine, western larch, and mountain hemlock. Douglas-fir commonly comprises 25 to 35 percent of the volume and is of Site Class IV and V.

Landform

The topography of Land Area C has variable characteristics. For instance, Mapping Unit 9 is void of vegetation and is extremely steep. The soils are shallow and intermittent, and the bedrock is soft and unstable. The Blue Slide on the Tieton Ranger District is a good example.

Other topography within the area has the appearance of a large amphitheater, containing a steep headwall with hummocky, gently sloping topography below. These areas are generally wet with many small ponds, and leaning trees are common. The upper Milk Creek drainage area is typical of this type of topography.

A third situation is the unstable sideslopes and toeslopes that commonly contain many drainages with steep and uneven slopes. The uneven appearance is caused by previous and present slide activity along the drainages.

Mapping Units

The mapping units on this area are 9, 38, 46, 75, 378 and 835.

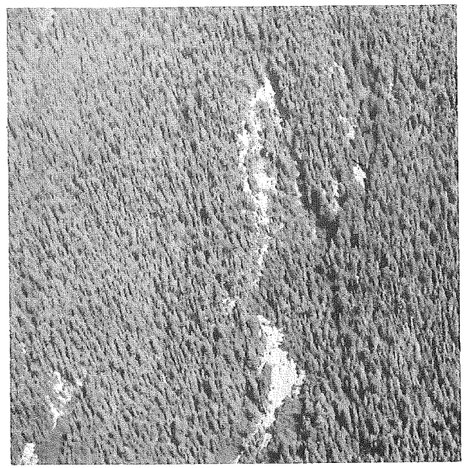
Soils

The soils in this area are generally moderately deep to very deep with the exception of Mapping Unit 9, which commonly has exposed soft bedrock. Soils are most often fine- and moderately fine-textured clays, silty clay loams or clay loams, and are moderately well to imperfectly drained.

1/ Because of the scattered and localized nature of this area, numerous small areas occur that are too small to delineate on the Land Area Maps. These locations are shown by the symbol x.

Bedrock

The bedrock of this area generally consists of soft, highly weathered and incompetent pyroclastic and sedimentary rocks.



Land Area C is composed of unstable soils. This slide is occurring on Mapping Unit 46 which is a highly unstable component of Area C.

Figure 5. View of Land Area C

Some Important Soil Limitations and Interpretations

This area has the following important limitations and interpretations:

Watershed

1. Natural Stability - These land area delineations are either unstable throughout or contain numerous unstable soils. This instability is caused by combinations of deep plastic soils, highly weathered bedrock, steep slopes and subterraneous water. Deep-seated mass movements are often observable both on the ground and on aerial photographs. Mapping Units 9 and 46 are the most unstable. Next are Mapping Units 38 and 75, followed by Mapping Units 378 and 835.

2. Expected Mass Movement as a Result of Man's Activities - The rate of failure is expected to greatly increase over the natural state as a result of road construction and timber harvest activities.

3. Surface Erosion - These soils have the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

4. Sediment Yield Potential - The soils of this land area have a very high potential to yield large amounts of sediment to streams whenever they are exposed such as in harvest units or on road cutbanks and fill slopes. The soils are high in silt and clay which can remain in suspension for extended periods and can cause damage to water and fishery resources, and shorten the lives of reservoirs. Water draining from these land areas often is turbid. Some streams run murky throughout much of the year. Much of this sediment may be contributed by failures on road cutslopes and fill slopes.

Engineering

1. Susceptibility to Cutbank Slough and Ravel - This is a severe problem on these soils. The exposed cutbanks continually slough and ravel, resulting in high maintenance and causing potential losses to soil and watershed values.

2. Probability of Cutbank Failures - These soils have the probability that from 6 to greater than 15 failures of at least 10 cubic yards each will occur per mile. What is perhaps more significant is the probability than an occasional failure of 50 cubic yards or larger may occur.

3. Failure and Erosion on Road Waste and Fills - This is a severe problem on these soils. When this occurs near streams it provides sediment that may be damaging to the water resource.

4. Considerations for Road Location and Construction - In addition to the problems discussed in previous interpretations, roads on these soils will often require relatively thick base course and frequent culverts. Compaction of fills may be difficult because of excessive moisture. Cutbank stability control may require measures such as planting of willow shoots and the local installation of horizontal drains and/or binwalls.

Selected Soil and Water Impacts from Certain Management Practices

There are different ways in which management activities can have an impact on soils and water. Some of these are as follows:

Timber Harvest - Timber harvest can have several adverse effects on Land Area C. Timber harvest and associated road activities can cause soil disturbance and slides resulting in erosion, sedimentations, unsightly scars and land lost from production. Slide activity may increase after timber removal on Mapping Units 46 and 78. The removal of trees reduce transpiration, resulting in increased soil water. This reduces internal friction and cohesion that may cause an increase in slump and slide activity. Also, as tree roots decompose, their soil stabilization effects from soil binding are lost.

1. Timber Harvest Methods

Some timber harvest methods cause considerably more damage than others. The impacts from several common methods are evaluated as follows:

a. Tractor - Although much of Soil 46 occurs on slopes of less than 35 percent, severe soil damage can result from tractor logging, especially when soils are wet. Tractor turning and log skidding causes soil displacement and compaction damage. Soil compaction and puddling is likely to occur which impedes water infiltration, reduces the soil's capacity to store water, and allows water to accumulate and run over the surface. Severe erosion may follow which results in high stream sedimentation.

Compaction also has an adverse effect on regeneration and tree growth. Compacted soils restricts root penetration which limits their moisture and nutrient intake to the surface few inches of soil. By late summer, this layer of soil can become droughty and survival of seedlings may be endangered. Tree growth will be inhibited, and as the tree becomes taller, it will be more susceptible to windthrow. This is because roots have been unable to penetrate the compacted soil and properly anchor the tree.

Compaction may be especially severe near vicinity of tractor landings because of the numerous passes of equipment and logs. The potential damage is severe on other soils in the area because of steep unstable soils. Tractor operation could greatly increase the slump and slide activity.

b. Partially Suspended Cable System - This method has the potential to cause severe soil damage. Damage may be caused by logs becoming temporarily airborne prior to slamming into and gouging the soils. This may trigger surface slides and cause soil displacement and compaction that allows soils to be vulnerable to erosion damage. Much of the damage is related to access roads depending upon their design, location and frequency. Roads have a high impact potential as cutbanks and fill slopes slough, ravel and fail, and there is potential for a high rate of massive failure.

c. Fully Suspended Cable System - This method may cause slight to moderate soil damage. Much depends on the location of landings and the frequency and design of access roads, as these are the significant contributors to damage. In general, little damage would be expected from the actual harvest operation. However, on the most unstable soils, tree removal may have some effect on stability as was discussed previously.

d. Aerial Logging - The impact on soils is comparatively low. The absence of skidding and roads removes the primary causes of soil disturbance. The problem of tree removal in relation to evapotranspiration and root decay becomes the only major impact.

2. Engineering Practices

The soil and water impact from roads can be very severe on these soils. Many studies on similar areas have indicated that roads are the major contributor to soil and water damage. Their construction

has a high probability of upsetting the critically balanced landscape. The various situations discussed below have been observed to occur on Land Area C.

a. On active landslide areas (Mapping Unit 46), roads are generally short-lived. Becaused the landslide movement is deep-seated, a road can be completely displaced and/or badly damaged in a short time, usually during the period of optimum soil water. This has occurred on the main Milk Creek Road and at several locations on spur roads in the same drainage. Road cuts through soils and bedrock of this land area have a high probability of incurring failures. Some can be of major size where heavy equipment will be required to remove the material from the road. This results in expensive maintenance and may cause severe damage to other resources.

b. Large and small cutbank failures frequently occur. In Land Area C where the stability is critical, as noted by the natural slide and slump activity, there is good reason to suspect that a road cut may trigger a slump or slide. The size of any one slide or slump is not predictable. Many factors combine which determine the size and frequency of cutbank failures. A few are listed below:

(1) Height of cutbank.

(2) Texture of the soil materials (the finer the soil texture, i.e., the greater the percent of clay particles, the more water it can hold). Water adds weight to the slope and acts like a lubricant to the soil.

(3) Bedrock hardness -- bedrock in this land area is generally soft and much of it is common material in engineering terminology. It too can hold large quantities of water which adds to the instability of the slope.

(4) Presence of water in and on the slope.

c. Fill slope failures are common on this land area. These materials, unless specially treated (air-dried or limed), seldom attain the optimum moisture content necessary for proper compaction. As a result of improper compaction, these materials readily absorb water which increases their failure potential.

The impacts to both soils and other resources as a result of road cuts on this land area are very high. Erosion, sedimentation, land lost from production, and unsightly scars all have severe impacts. Fisheries may be damaged or destroyed, water quality reduced, and life expectancy of reservoirs shortened--these are but a few of the long-lasting effects related to road failures.

LAND AREA D

Steep, Smooth, Slightly-Dissected Sideslopes that Support Grass, Ponderosa Pine, or Ponderosa Pine/Douglas-fir.

Land Area D consists of shallow to deep, stable to moderately stable soils on the steep sideslopes that occur on the relatively dry eastern part of the inventory area. The majority of the land area occurs between 1,800- and 4,000-feet elevation.

Land Area D occurs primarily in the Principal Forest Resource Zone with a small portion overlapping into the Grass-Shrub Resource Zone. The timber generally consists of Douglas-fir and ponderosa pine, with scattered ponderosa pine, grass and shrubs occurring locally. Douglas-fir comprises approximately 30 to 40 percent of the overall timber volume. Douglas-fir site is generally Site Class IV and V.

Landform

The topography most commonly consists of steep (35 to 70+ percent) smooth, slightly-dissected sideslopes (slopes on Mapping Units 36, 52 and 536 may be moderately dissected). Rock outcrops are occasionally present.

Mapping Units

The Mapping Units on this area are 13, 31, 36, 52, 61, 62, 81, 536, 621 and 813.

Soils

The soils in this area are somewhat variable. Their major characteristics are described briefly as follows:

Soil 13 is well drained, very gravelly, moderately coarse-textured, and is over 12 feet deep.

Soil 36 is well to moderately well drained and is highly variable in texture, ranging from gravelly moderately coarse to gravelly moderately fine. Depth to bedrock ranges from 4 to 10 feet.

Soils 31, 52, 61, 62 and 81 are well drained, gravelly moderately coarse to gravelly medium-textured. Depth to bedrock is generally less than four feet.

Soils 536, 621 and 813 are complexes, each consisting of two of the previously defined soils.

Bedrock

The bedrock of this area is variable and includes andesite, basalt,

pyroclastic, sedimentary or granitic. These rocks range from hard and competent to moderately hard and less competent. Some pyroclastic rocks may be soft.

Some Important Soil Limitations and Interpretations

This area has the following important limitations and interpretations:

Watershed

Surface Erosion - This area has a severe surface erosion potential. The soils are fragile, weakly structured, and offer little resistance to raindrop impact and dispersion when their protective vegetative cover and duff layers are removed. Once mineral soil is exposed on these steep slopes, runoff from melting snow or heavy rains (such as from thunderstorms) may cause severe erosional losses.

Timber Management

Limitations to Tree Growth - Limitations to growth are present to some degree, on much of this area because of soil moisture deficiencies during the summer and fall months, especially on south-facing slopes. Precipitation is relatively low and summer soil temperatures are quite high. Many of the soils are shallow and have limited moisture-holding capacity. During the summer and fall, moisture levels fall below that required for tree growth. Soil 61, for example, becomes so droughty that it is unable to support but few trees. Other soils also have areas in which scattered trees occur. The importance of this is to realize that in areas where poorly stocked tree stands occur naturally, it generally indicates that the available soil moisture is insufficient to support denser stands. Often, in these areas, the roots extend out for considerable distance from each tree in order to utilize what soil moisture is available. To increase the stocking would cause a greater drain on the soil moisture supply than is available.

Engineering

Susceptibility to Cutbank Sloughing and Raveling can be a problem, especially on Soils 36 and 536 where frequent maintenance may be required.

Selected Soil and Watershed Impacts from Various Management Practices

There are different ways in which various practices will have an impact on soils and water. Some of the common practices and their impacts are evaluated as follows:

1. Timber Harvest Methods

   a. Tractor - The soils in Area D are generally much too steep (greater than 35-percent slope) to be tractor operable without causing excessive soil loosening and displacement that would likely be followed by severe erosion. (See "Common Soil Problems.")

b. Partially Suspended Cable System - This method can be expected to cause low to moderate soil damage depending upon the steepness of slope and the design and frequency of access roads. (For discussion of damage, see section "Common Soil Problems.")

Much of the total damage caused on these soils is related to the roads. Roads may cause considerable soil exposure on cutslopes and wasteslopes that are subject to erosional losses. Soils that are damaged, whether on roads or in harvest units, are often difficult to revegetate because of soil moisture limitations. This allows exposed soils to be subjected to erosional losses for extended periods.

c. Fully Suspended Cable System - This method can be expected to cause little or no soil damage. However, damage may be caused by road construction and would involve the same considerations as previously discussed.

2. Engineering Practices

Roads have a low to high impact potential on soil and water values. The potential for damage is related to such factors as steepness of slope, proximity to streams, and road design and frequency. A major impact is from failures of excavation waste when sidecast, or on uncompacted fills, especially on slopes over 60 percent. This material often ravels and erodes and is often difficult to stabilize. Water runoff from heavy rains or spring snowmelt often flows across the road prism and on to wasteslopes and fillslopes, causing severe erosion. The erosion problem is intensified as they are often very difficult to vegetate and require intensive treatment to minimize the erosional problems.

LAND AREA E

Steep, Smooth, Slightly to Highly Dissected Sideslopes that Support Mixed Conifer Stands

Land Area E consists of shallow to deep, stable to moderately stable[1/] soils on steep sideslopes that occur in various locations on the western two-thirds of the inventory area. Most of this area occurs between 3,000- and 6,000-feet elevation.

Land Area E occurs in the Principal and Upper Forest Resource Zone. The timber composition is quite variable and includes Douglas-fir, true fir, western larch, mountain hemlock and white fir. Douglas-fir comprises approximately 20 to 30 percent of the overall timber volume and is generally Site Class V.

Landform

The topography most commonly consists of steep (35 to 70 percent) smooth, slightly to moderately dissected sideslopes (slopes on Mapping Units 72, 83 and 92 are highly dissected). Rock outcrops are occasionally present.

Mapping Units

The mapping units on this area are 15, 27, 32, 37, 53, 63, 71, 72, 82, 83, 91, 92, 537, 557, 625, 823, 827 and 915.

Soils

The soils in this area are quite variable. Their major characteristics are described briefly as follows:

Depth - Soils 15 and 27 are greater than 12 feet deep. Soil 37 ranges from 3 to 12 feet. The remaining soils are generally less than 4 feet deep over various bedrock types.

Texture - Soils 15, 91 and 92 are generally very gravelly and cobbly sandy loams or loamy sands. Soils 32, 82 and 83 include gravelly sandy loams, loams and silt loams. The remaining group of soils has textures of gravelly loams, silt loams or silty clay loams.

Bedrock

The bedrock of this area is variable and includes andesite, basalt, pyroclastic, sedimentary or granitic. These rocks range from hard and competent to moderately hard and moderately competent. Some pyroclastic rocks may be soft.

Some Important Soil Limitations and Interpretations

This area has the following important limitations and interpretations:

1/ Portions of Mapping Unit 72 are unstable.

Watershed

Surface Erosion - The soils in this area have the potential for severe surface erosion when the protective duff and vegetative cover is removed (see "Common Soil Problems)." The problem is intensified in this area by the fact that natural vegetation is often slow to return and grass seeding has a poor chance of success. This may allow soils to be exposed to erosion for extended periods.

Timber Management

Limitations to Regeneration and Tree Growth - The soils in parts of this area have limitations to regeneration and tree growth that are caused by soil and climatic factors. (See "Common Soil Problems" and discussions under individual soils.)

Engineering

Failure and Erosion on Road Waste and Fills can be a problem, especially on Soils 27, 37, 72 and 83. This may require considerable maintenance and causes potential damage to soil and water values.

Selected Soil and Watershed Impacts from Various Management Practices

There are different ways in which various practices will have an impact on soils and water. Some of the common practices and their impacts are evaluated as follows:

1. Timber Harvest Methods

   a. Tractor - The soils in Area E are generally much too steep (greater than 40-percent slope) to be tractor operable without causing excessive soil loosening and displacement that would likely be followed by severe erosion (see "Common Soil Problems").

   b. Partially Suspended Cable System - This method can be expected to cause low to severe soil damage, depending upon the steepness of slope and the design and frequency of access roads. (See "Common Soil Problems".) Much of the total damage caused on these soils is related to the roads. Roads may cause considerable soil exposure on cutslopes and wasteslopes that are subject to erosional losses. Soils that are damaged, whether on roads or in harvest units, are often difficult to revegetate due to poor grass seeding success. This allows exposed soils to be subjected to erosional losses for extended periods.

   c. Fully Suspended Cable System - This method can be expected to cause little or no soil damage from the harvest method. However, damage may be caused by road construction and would involve the same considerations as previously discussed.

2. Engineering Practices

The potential impact from roads ranges from low to high and is related to such factors as steepness of slope, soil and bedrock type, proximity to streams, and road design and frequency. A major impact is from failures of excavation waste when sidecast, or of uncompacted fills, especially on slopes over 60 percent. This material often ravels and erodes and is often difficult to stabilize. Water runoff from heavy rains or spring snowmelt often flows across the road prism and onto wasteslopes and fill slopes, causing severe erosion. The erosion problem is intensified as they are often very difficult to revegetate and require intensive treatment to minimize the erosional problems.

LAND AREA F

Steep, Dissected Sideslopes in the Nile Creek Area

Land Area F consists of shallow to moderately deep soils on steep, dissected sideslopes that occur in the Nile Creek-Dry Creek drainages and tributaries. Most of this area lies between 2,300- and 3,600-feet elevation.

Land Area F occurs in the Principal Forest Resource Zone. The timber generally consists of ponderosa pine, Douglas-fir, white fir and western larch. Douglas-fir comprises approximately 25 to 35 percent of the volume and is of Site Class IV and V.

Landform

The topography consists of steep slopes that range from 35 to 80 percent slope. The slopes are characteristically highly dissected with both parallel and dendritic drainage patterns.

Mapping Units

The mapping units on this area are 33, 34, and 334.

Soils

The soils of this area in general range from shallow to moderately deep (1 to 4 feet). Surface soils are generally thin sandy loams, while subsoils generally range from gravelly loams to gravelly silty clay loams. These soils are generally well drained. Soil 33 differs from Soil 34 with respect to aspect. Soil 33 is more droughty because it occurs on south-facing slopes and has a somewhat shallower average soil depth. As a result, these soils support open stands of ponderosa pine with some Douglas-fir. Soil 34 has more dense stands of Douglas-fir, white fir and western larch on north-facing slopes where soils tend to be deeper.

Bedrock

The bedrock in this land area is comprised of water-laid pyroclastic rock. The rock is generally soft and moderately competent throughout.

Some Important Soil Limitations and Interpretations

This area has the following important limitations and interpretations:

Watershed

1. Severe Erosion Potential - This land area has a severe surface erosion potential. The dense dendritic and parallel stream systems in this area indicate that natural geologic erosion is proceeding at a rapid pace and can easily be accelerated by management activities.

The surface soils are generally loose and are easily detached by raindrop impact and running water when duff cover is damaged or destroyed and running water has been allowed to accumulate. The potential for erosion from running water is especially severe on south slopes because of the sparse vegetative and duff cover.

2. Stream Damage Potential - Because of the steep and highly-dissected topography, there is ample opportunity for road waste and harvest slash to enter into the sideslope drainage channels. This material may be periodically flushed out and contribute debris and sediment to the major streams.

Timber

Limitations to Regeneration and Tree Growth - Regeneration is not a major problem on Soil 34. On Soil 33, however, there can be problems with both naturals and plantations. Since these soils occur on south-facing slopes, they receive direct sun which rapidly depletes the soil moisture. Soil temperatures are high and soil moisture often becomes limiting for tree growth by early summer. Ponderosa pine have the tolerance to survive, but, in general, are widely spaced because of competition for water. In general, these soils are fairly infertile and can supply only limited amounts of nutrients. Douglas-fir have a low chance for survival under these conditions.

Engineering

Susceptibility to Cutbank Sloughing and Raveling is high on these soils. Cutbanks continually slough and erode, requiring frequent maintenance.

Selected Soil and Water Impacts from Certain Management Practices

Some of the common practices and their impacts on soil and water values are evaluated as follows:

1. Timber Harvest Methods

   a. Tractor - The soils in Area F are generally much too steep (greater than 40-percent slope), dissected, and erodible to be tractor operable without causing excessive soil loosening and displacement that would likely be followed by severe erosion (see "Common Soil Problems").

   b. Partially Suspended Cable System - This method has the potential for causing moderate damage over much of the area because of the easily eroded soils and the steep, dissected slopes. The actual damage incurred depends to a large extent on the slope configuration at the harvest area, and the design and frequency of access roads. (See "Common Soil Problems.") Much of the total damages caused on these soils is related to roads. Roads may cause considerable soil exposure on cutslopes and wasteslopes that are

subject to extensive erosional losses through sloughing and raveling. Soils that are damaged, whether along roads or on harvest units, are often difficult to revegetate because of poor grass seeding success. This allows exposed soils to be subjected to erosional losses for extended periods.

c. Fully Suspended Cable System - This method can be expected to cause minimal soil damage. However, damage may be caused by road construction and would involve the same considerations as previously indicated.

2. Engineering Practices

Roads have a moderate to high impact potential on soil and water values. Much depends upon the steepness of slope, road design and frequency, and the extent to which road excavation and maintenance waste is prevented from entering stream channels. Wasteslopes, fill slopes and cutslopes slough and erode extensively, are difficult to stabilize, and may contribute sediment to streams. The sloughing cutslopes often divert drainage water from heavy rains or spring snowmelt across the road prism and onto the wasteslope, thereby intensifying the erosional problems. The erosion problem is further intensified as exposed soils are often difficult to revegetate and require intensive treatment to minimize the erosional problems.

LAND AREA G

Moderately Deep to Deep, Stable to Moderately Stable Soils on Gentle Slopes that Support Ponderosa Pine or Ponderosa Pine/Douglas-fir Stands

Land Area G consists of moderately deep to deep, stable to moderately stable[1/] soils on gentle slopes within the eastern one-third of the inventory area. This land area occurs on slopes of less than 35 percent in valley bottoms, on gentle sideslopes or on ridgetops. The major part of this land area lies between 1,800- and 4,000-feet elevation.

Land Area G is primarily in the Principal Forest Resource Zone. The timber generally consists of ponderosa pine and Douglas-fir. Douglas-fir comprises approximately 30 to 40 percent of the volume and is of Site Class IV and V.

Landform

The topography consists of gentle (0-35 percent) slopes that vary in shape from nearly smooth and flat to somewhat uneven and hummocky.

Mapping Units

The primary mapping units on this area are 42, 44 and 424.

Soils

The soils in this area are quite variable. Depth of soils ranges from 5 to greater than 12 feet. The surface soils are generally sandy loams or loams; whereas, the subsoils range from well drained sandy loams to imperfectly drained clays. This wide variability in soils is related to the wide physical and weathering characteristics of the underlying pyroclastic bedrock.

Bedrock

The bedrock consists primarily of weathered, soft, moderately competent to incompetent pyroclastic rock.

Some Important Soil Limitations and Interpretations

This area has the following important limitations and interpretations:

Watershed

Sediment Yield Potential - Whenever these soils are exposed, especially Soil 44, they have a high potential to yield sediment of silt and clay to streams. Much of this sediment may remain in water suspension for extended periods, causing damage to water quality and fishery values.

1/ This is stability in the natural state. Often, Soil 44 is unstable when disturbed.

Engineering

1. Susceptibility to Cutbank Sloughing and Raveling can be a severe problem, especially on the steeper slopes where sloughing and raveling may require frequent maintenance. Also, the frequently exposed raw soil materials provide sediment source that may be harmful to water quality and fisheries.

2. Probability of Cutbank Failures - These soils have the probability that from 3 to greater than 15 cutbank failures of at least 10 cubic yards each will occur per mile. (This applies to cutbanks over 10 feet in height, and the most frequent occurrence would be expected on Soil 44 and on portions of Soil 424.)

3. Considerations for Road Location and Construction - In addition to problems discussed in previous interpretations, these soils require relatively thick base course on roads used year long, especially on Soil 44. This soil may also require cutbank stability measures such as planting of willow shoots or locally installing horizontal drains and/or retaining structures.

Recreation

1. Suitability for Recreation Area Development - These soils have low to moderate suitability. Trampling may destroy vegetation and compact soils to the extent that revegetating the area can be difficult. Further limitations result from drainage restrictions and muddiness potential, especially on Soil 44.

2. Suitability for Sewage Filter Field - These soils have poor to moderate suitability. Limitations are caused by drainage restrictions (especially Soil 44) that may result in contamination at the surface and to nearby bodies of water.

Range

Susceptibility to Damage by Cattle - Concentrations of cattle or other hoofed animals can cause severe vegetation and soil compaction damage on these soils. Soil disturbance can become especially severe along streambanks and can significantly contribute to sedimentation.

Selected Soil and Water Impacts from Certain Management Practices

There are different ways in which management activities can have an impact on the soils. Some of these are as follows:

1. Timber Harvest Methods

   a. Tractor - The potential impact on soils from tractor operation is likely to be moderate to high. Tractor turning and log skidding causes soil loosening, displacement and compaction damage. The

potential for compaction damage is highest on Soil 44, especially when wet. Soil compaction impedes water infiltration, reduces the soil's capacity to store water, and allows water to accumulate and run over the surface. Increased erosion and high stream sedimentation may result. Compaction also has an adverse effect on regeneration and tree growth. Compacted soils restrict infiltration, aeration and root penetration. This may be detrimental to seedling survival. Seedlings that survive will grow slower, and as they become taller, they will be more prone to windthrow. This is because roots have not been able to penetrate the compacted soil and properly anchor the tree.

The potential impact on and in the near vicinity of tractor landings is especially high because of numerous passes of equipment and logs over these areas.

   b. Partially Suspended Cable System - The impact on soils is likely to be low to moderate (locally high in Soil 44 due to road damage). Logs which are skidded on these soils will eventually compact soils, remove duff protection and provide channels for water accumulation, resulting in erosion of soils and sedimentation of streams. Gouging which causes displacement, loss of vegetation and compaction is generally greater on the more hummocky or uneven soils of this land area. Much also depends upon the location, design and frequency of access roads.

2. Engineering Practices

Roads may have a low to high impact on soil and water values in this area, with the highest impact expected on Soil 44. On this soil especially, roads increase the potential for slumps. Cutslopes and wasteslopes slough, ravel and erode and have a high potential for failure. These soil movements may contribute sediment to streams that may cause losses to water quality and fishery values.

LAND AREA H

Moderately Deep to Deep, Stable to Moderately Stable Soils on Gentle Slopes that Support Mixed Conifer Stands

Land Area H consists of moderately deep to deep, stable to moderately stable[1/] soils on gentle slopes within the western two-thirds of the inventory area. This land area occurs on slopes of less than 35 percent in valley bottoms, on gentle sideslopes or on broad ridgetops. The major part of this land area lies between 3,000- and 5,000-feet elevation.

Land Area H occurs in both the Principal and Upper Forest Resource Zones. The timber generally consists of Douglas-fir, white fir, mountain hemlock and western larch. Douglas-fir comprises approximately 25 to 40 percent of the overall volume and is most commonly Site Class V.

Landform

The topography consists of gentle (0-35 percent) slopes that vary in shape from nearly smooth and flat to somewhat uneven and hummocky.

Mapping Units

The primary mapping units on this area are 26, 43, 45, 76, 435 and 643.

Soils

The soils in this area are quite variable. Depth of soil ranges from 3 feet to greater than 12 feet. The surface soils are generally sandy loams or loams; whereas, the subsoils range from well drained sandy loams to imperfectly drained clays. This wide variability in soils is related to the wide physical and weathering characteristics of the underlying bedrock.

Bedrock

The bedrock of this area consists primarily of weathered, soft, moderately competent to incompetent pyroclastic rock. However, hard and competent basalts and andesites occur on Mapping Unit 643 and are occasionally found in Mapping Unit 43. Mapping Unit 76 has moderately competent bedrock consisting primarily of interbedded sediments.

1/ This is stability in the natural state. Often Soil 45 is unstable when disturbed.



Figure 6. View of Land Area H

The photo shows the gently rolling topography that is characteristic of Land Area H. Cutbank slough and failures are common, especially on Mapping Unit 45 as shown here. Land Area G is similar except for differences in timber types.

Some Important Soil Limitations and Interpretations

This area has the following important limitations and interpretations:

Watershed

Sediment Yield Potential - Whenever these soils are exposed, especially 45 and 435, they have a potential to yield sediment of silt and clay to streams. Much of this sediment may remain in water suspension for extended periods, causing damage to water quality and fishery values.

Engineering

1. Susceptibility to Cutbank Sloughing and Raveling is a problem, particularly on the steeper portions of Soils 45 and 435 where sloughing and raveling may require frequent maintenance. Also, the exposed raw soil materials provide sediment source that may be harmful to water quality and fisheries.

2. Probability of Cutbank Failures - Soil 45 and part of 435 have a high probability of cutbank failures. These soils have the probability that from 9 to greater than 15 cutbank failures of at least 10 cubic yards each will occur per mile. (This applies to cutbanks over 10 feet in height.)

3. Considerations for Road Location and Construction - These soils require relatively thick base course on roads used year long, especially on Soils 45 and 435. The more unstable portions of these soils may require cutbank stability measures such as planting of willow shoots or locally installing horizontal drains and/or retaining structures.

Recreation

1. Suitability for Recreation Area Development - These soils have low to moderate suitability. Trampling may destroy vegetation and compact soils to the extent that revegetating the area can be difficult. Further limitations result from drainage restrictions and muddiness potential, especially on Soils 45 and 435.

2. Suitability for Sewage Filter Field - These soils have poor to moderate suitability. Limitations are caused by drainage restrictions (especially Soil 45) that may result in contamination at the surface and to nearby bodies of water.

Range

Susceptibility to Damage by Cattle - Concentrations of cattle or other hoofed animals can cause severe vegetation and soil compaction damage on many of these soils. Soil disturbance can become especially severe along streambanks and can significantly contribute to sedimentation.

Selected Soil and Water Impacts from Certain Management Practices

There are different ways in which management activities can have an impact on the soils. Some of these are as follows:

1. Timber Harvest Methods

   a. Tractor - The potential impact on soils from tractor operation is moderate to high. Tractor turning and log skidding causes soil loosening, displacement and compaction damages. The potential for compaction damage is highest on Soil 45 and followed by 435, especially when wet. Soil compaction impedes water infiltration, reduces the soil's capacity to store water, and allows water to accumulate and run over the surface. Increased erosion and high stream sedimentation may result. Compaction also has an adverse effect on regeneration and tree growth. Compacted soils restrict infiltration, aeration and root penetration. This may be detrimental to seedling survival. Seedlings that survive will grow slower and as they become taller, they will be more prone to windthrow. This is because roots have not been able to penetrate the compacted soil and properly anchor the tree.

   The potential impact on and in the near vicinity of tractor landings is especially high because of numerous passes of equipment and logs over these areas.

   b. Partially Suspended Cable System - The potential impact ranges from low to moderate (locally high on 45 and 435 due to road damage). Logs which are skidded on these soils will have the potential to compact soils, leave soils unprotected by duff, and provide channels for water accumulation, resulting in erosion of soils and sedimentation of streams. Gouging which causes displacement, loss of vegetation and compaction is generally greater on the more hummocky or uneven soils of this land area. Much also depends on the location, design, and frequency of access roads.

2. Engineering Practices

Roads may have a high impact on Soil 45 and portions of Soil 435. Roads increase the potential for slumps and slides. Cutslopes and wasteslopes slough, ravel and erode and have a high potential for failure. These soil movements may contribute sediment to streams that may cause losses to water quality and fishery values.

LAND AREA I

Very Deep, Coarse to Moderately Coarse-Textured, Stable Valley Bottom Soils

Land Area I generally consists of very deep (greater than 12 feet), coarse- to moderately coarse-textured stable soils that occur in rather localized areas of the inventory area. Generally, the soils of this area occur in major valley bottoms. However, Soil 14 also occurs in cirque basins or on terraces. An example of this is Pinegrass Ridge. Land Area I is small in extent and only occupies approximately 5 percent of the inventory area. The elevation range is broad and extends from 1,800 to 6,000 feet.

Land Area I occurs primarily in the Principal Forest Resource Zone, although some localized cirque basins containing Soil 14 are characterized by the Upper Forest Resource Zone. The timber consists of ponderosa pine and Douglas-fir at lower elevations, and true fir, mountain hemlock, western redcedar, Douglas-fir, western larch, white fir and lodgepole pine at higher elevations. Douglas-fir comprises approximately 10 to 20 percent of the overall volume, and is generally Site Class IV and V.

Landform

The topography consists of flat to gently-sloping (0-35 percent) flood plains, valley bottoms and toeslopes along with a few terraces and cirque basins.

Mapping Units

The mapping units on this area are 10, 11, 12 and 14.

Soils

The soils are characteristically very deep and generally lack structure. The surface soils are generally gravelly sandy loams or loamy sands. Subsoils are noncompacted to weakly compacted (moderately compacted locally) very gravelly and stony loamy sands or sandy loams. These soils are normally well drained except locally in Soil 14 where drainage is restricted because of subsoil compaction.

Bedrock

The bedrock of this area is generally greater than 12 feet beneath the soil surface and may be andesite, pyroclastic, sedimentary or granitic.



Figure 7. View of Land Area I

This photo shows the gentle slope valley bottom or terrace topography that is characteristic of Land Area I.

Some Important Soil Limitations and Interpretations

This area has the following important limitations and interpretations:

Timber Management

Limitations to Regeneration and Tree Growth - There are several limitations in this area. Some of the limitations can be attributed to either hot temperatures and low soil moisture, or cold soils. All the soils are relatively infertile because of coarse textures.

Soils 10 and 12 experience high summer soil temperatures, and because of low moisture-holding capacity they often become droughty, especially in the eastern one-third of the inventory area.

Soil 11 is excessively drained and is, therefore, quite droughty for long periods of the year. As a result, the understory vegetation is limited, and lodgepole pine becomes the dominant overstory species.

Soil 14 may receive cold downslope air at the heads of valleys which causes cold soil conditions. This causes slow microbiological activity which results in slow nutrient release. The growing season is generally shorter and frost heave is more common.

Recreation

1. Suitability for Recreation Area Development - These soils are well to moderately well suited. Limitations that are present are caused by local wet areas or because of some hazard of occasional flooding.

2. Suitability for Sewage Filter Field - Slopes under 10 percent slope have various degrees of suitability. Soil 10 has severe limitations because of flooding hazard and high water table. Soil 11 has very rapid permeability and, therefore, requires considerable distance from bodies of water to prevent contamination. Soils 12 and 14 have variable limitations depending upon local drainage and proximity to streams and ponds that could become polluted. Slopes in excess of 10 percent on all soils are generally unsuited because of steepness.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods

a. Tractor - Some soil damage can result from tractor turning and blade and log gouging that may cause soil loosening and displacement. Damage may range from slight to moderate. The amount of damage depends to a large extent on the care and skill of the tractor operator.

b. Partially Suspended Cable System - Only minimal soil damage would be expected with this system.

LAND AREA J

Shallow to Moderately Deep Soils over Basalt or Andesite Bedrock - Tableland Areas

Land Area J consists of shallow to moderately deep soils that occur generally on flat ridgetops over hard basaltic or andesitic rock. This area occupies approximately 5 percent of the inventory area and is somewhat localized. One fairly large part occurs just north of White Pass. A second large part occurs at the south end of Pinegrass Ridge. The majority of the remaining land area occurs on the eastern one-third of the inventory area. The elevation range is broad and extends from 2,000 to 6,000 feet.

Land Area J is spread throughout the Upper, Principal and Grass-Shrub Resource Zones. Tree species occurring in various locations throughout the area include ponderosa pine, Douglas-fir, true fir, western larch, western white pine, white fir, mountain hemlock and Engelmann spruce.

Landform

The topography consists primarily of flat to gently sloping (0 to 35 percent) ridgetops. These are remnants of old lava flows.

Mapping Units

The mapping units on this area are 64, 65, 66, 67, 664 and 665.

Soils

The soils in this area are generally shallow to moderately deep. Soil 64 is a gravelly loam to silt loam soil that is about 12 inches deep to bedrock. The other soils in the area generally range from 2 to 5 feet in depth and have gravelly loam or sandy loam textures. These soils are generally well drained except for small local areas.

Bedrock

The bedrock generally consists of hard unweathered andesite or basalt.



Figure 8. View of Land Area J

This flat tableland is characteristic of Land Area J. The open areas are Soil 64. This soil is very shallow and becomes so droughty that it is unable to support trees.

Some Important Soil Limitations and Interpretations

Timber Management

1. Limitations to Regeneration and Tree Growth - Limitations to regeneration and growth are present on much of this area because of soil and climatic factors. In the eastern part of the area, especially on Soils 64, 65 and 665, there are severe growth limitations because of low precipitation, hot summer soil temperatures, and very limited moisture-holding capacity. During the summer and fall, moisture levels fall below that required for tree growth. Soil 64, for example, becomes so droughty that it is unable to support trees. Other soils in the area have areas in which scattered trees occur. The importance of this is to realize that in areas where poorly stocked tree stands occur naturally, it generally indicates that available soil moisture is insufficient to support denser stands. Often in these areas the roots extend out for a considerable distance from each tree in order to utilize what soil moisture is available. To increase the stocking would cause a greater drain on the soil moisture supply than is available.

   In the western portion of this land area, different growth limitations occur. On high-elevation soils, such as Soil 67, the primary

limitations are caused by the short growing season because of cold soils. Much of the year the soils have limited microbiological activity which is necessary in providing nutrients that are important to growth and the survival of seedlings. Also in much of this area the occurrence of frost heave can be an important factor in seedling survival.

2. Planting Species - Often, the most predominant natural tree species will give the best success when used as a regeneration species, as they have best adapted to existing soil and climatic conditions.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods

a. Tractor - The potential impact from tractor operation is relatively low. Some damage can occur, however, from tractor turning, log skidding and blade action that removes duff cover and damages soil structure. There is some potential for soil compaction on the silt loam soils. The extent of damage depends to a large extent on the tractor operation.

b. Partially Suspended Cable System - The potential impact is low; minor soil damage such as soil loosening and displacement may occur.

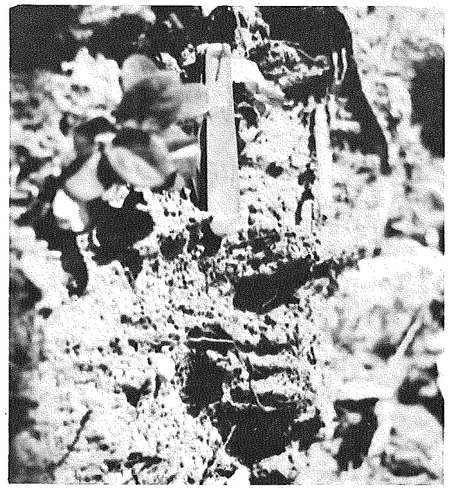
COMMON SOIL PROBLEMS

This section contains discussions of problems that are common to many mapping units. The purpose of this section is to reduce repetition of information.

Watershed

Surface Erosion - The majority of soils on slopes over 35 percent have the potential for severe surface erosion when the duff and vegetative cover is removed by management activities. Vegetation and duff removal, such as log skidding, slash disposal and road construction, results in soil exposure in harvest units and on road cutbanks, wasteslopes and fills (Figure 9).

The erosion potential is due to the soil characteristics and the steep slopes. Surface soils are generally weakly structured and offer little resistance to raindrop impact and dispersion, and transport by running water. Resistance to movement is further decreased if the soils are loosened and/or displaced by management activities (Figure 10).



Soil erosion is a common problem on all steep slopes when mineral soils are exposed on cutbanks, fill slopes, or in harvest units.

This picture shows the surface erosion that can occur from raindrop dispersion and transport on bare mineral soil. The top of the pedestals was the original soil level.

Figure 9. Soil Erosion



Gully erosion is occurring on this soil. The sequence of events may have begun by soils having been exposed to erosion by skidding damage. Subsequent water accumulation and runoff provided sufficient erosive force to cause the damage shown.

Figure 10. Soil Erosion

Throughout many of middle-elevation ranges, natural vegetation generally returns readily and grass seeding often has a fair-to-good chance for success. However, at high elevations throughout the area, and on most elevation ranges near the eastern edge of the area, there are severe soil and climatic limitations to growth. The soils at higher elevations are relatively infertile and soil temperatures are below that required for growth for long periods. Along the eastern edge, growth limitations are caused by hot summer soil temperatures and moisture deficiencies. Natural vegetation is often slow to return and grass seeding is frequently unsuccessful. This allows soils to be exposed to erosion for extended periods.

Timber Management

1. Factors Affecting Regeneration and Tree Growth - Many soils throughout the area have various limitations that affect regeneration and growth. The most severe limitations occur at higher elevations (above about 5,000 feet) throughout the survey area and on several soils along the eastern portion of the survey area. During much of the year at higher elevations, the soils are cold and have temperatures below that required for growth. Additional limitations are caused by the fact that soils are often relatively shallow and contain a high percentage of gravel and stones. This limits the soils nutrient status and their ability to retain sufficient moisture throughout the growing season.

   In the eastern portion, the major limitations are caused by a combination of low annual precipitation, low soil moisture-holding capacity,

and hot summer soil temperatures. These factors cause severe moisture stress throughout much of the growing season.

These are major limitations to all tree and plant growth, but are more limiting to some tree species than others. Often the most prevalent natural species in any given area has best adapted to existing soil and climatic conditions and can be expected to afford the best success when used as a regeneration species. Also, the factors discussed cause restrictions in time of planting. The best success can be expected when soil moisture and temperature conditions are satisfactory for growth. This usually occurs some time after the spring snowmelt.

2. Potential Soil Damage from Tractor Logging on Steep Slopes (over 35-percent Slopes) - Damage is caused by removing the duff, loosening the soil and causing soil displacement. Soil compaction may occur that impedes water infiltration, reduces the soil's capacity to store water, and allows water to accumulate and run over the surface. Raindrop impact on the exposed soils, along with water accumulating and running over the surface, is likely to cause severe erosion. Also, on steep slopes, downhill speed control and tractor stability may require running with the blade implanted in the soils. This causes additional soil disturbance that would likely be followed by severe erosion.

3. Potential Soil Damage from Partially Suspended Cable Systems on Steep Slopes - Damage may be caused by logs becoming temporarily airborne prior to slamming into and gouging the soils. This causes destruction of the protective duff cover, causes soil loosening and displacement, and may also cause soil compaction. Bare soils are then exposed to erosion. The problem is intensified by the straight-downslope configuration of skid trails. Running water in skid trails has the potential to reach high velocity and severely erode the soils. These soil impacts are increased during downhill logging where there is greater opportunity for the front end of the log to drag and "plow" through the soils. This, together with increased yarding speeds, may result in considerable soil displacement.

4. Potential Soil Damage from Slash Disposal Methods - Slash disposal causes various impacts upon the soil. Most of the common methods may have a greater or lesser impact, depending upon such factors as vegetative cover, duff thickness, wetness, soil texture and slope. The extent of impact from any one method often requires more precise information than is available in this report. Therefore, the methods are not evaluated with reference to any particular soils. The intent is to point out the type of soil damage that may occur from some common slash disposal methods. These are as follows:

   a. Potential Soil Damage from Broadcast Burning - Broadcast burning often causes duff destruction. An intensive burn will often destroy duff over wide areas and may have the following effects:

   Duff destruction causes a loss of nitrogen source and results in areas exposed to erosional forces. Soil physical changes may occur that reduce water intake and moisture-holding capacity and cause increased summer temperatures. This may result in hot, droughty summer soil conditions that are detrimental to the survival of seedlings, especially on southern exposures.1/

   b. Potential Soil Damage from Total Yarding - Considerable soil damage can result from cable-yarding of unlimbed culls. As these culls are yarded to the landing, the jagged limbs create furrows, causing destruction of duff and displacement of soils. The problem is intensified by the straight-downslope configuration of furrows. Running water in these furrows has the potential to reach high velocity and cause severe erosion. There is often widespread surface soil disturbance when many culls are yarded from the harvest unit. Also, the hot burn of the yarded and piled cull material is likely to cause localized severe soil damage such as decreased fertility and reduction in infiltration, porosity, and moisture-holding capacity, resulting in a reduction of productivity.

   c. Potential Soil Damage from Machine Pile - Soil damage may result from the frequent passes over the ground by tractors. In some areas, considerable soil loosening may be caused, resulting in increased erosion. In other areas, soil compaction may occur to the extent that infiltration, aeration and root penetration is severely impeded. This may have a detrimental effect on future tree growth. Also, the hot burn of the piled cull material is likely to cause localized severe soil damage such as decreased fertility and reduction in infiltration, porosity, and moisture-holding capacity, resulting in a reduction of productivity.

5. Soil and Water Impact from Roads - A common impact from roads on all soils over about 60-percent slope (some soils, because of instability, may receive severe impact on lesser slopes) is the effect of excavation waste when sidecast, especially into stream channels (Figure 11). Sidecast material ravels and erodes and is often difficult to stabilize. Stabilization is especially difficult on the cold, high-elevation soils, and the hot, dry eastern area soils where grass seeding is frequently unsuccessful because of severe soil and climatic limitations. Excavation waste that reaches streams is potentially harmful to water quality and fisheries. Severe problems may be caused when excavation waste is sidecast on the unstable soils such as 38 and 75. Sidecast waste may overload the wasteslope, causing large wasteslope failures. This may cause considerable damage to soil and water values. (Figures 12 and 13.)

1/ Neal, J. L., et al. Burning Douglas-fir slash; physical, chemical and microbicide effects in the soil. Forest Research Laboratory, Oregon State University, Corvallis. Research Paper, February 1965.

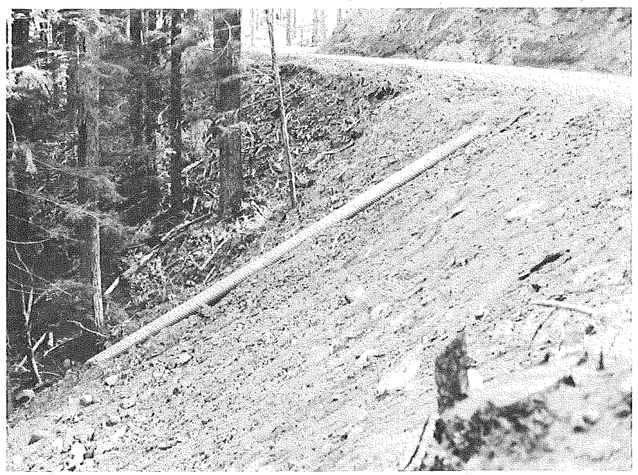


Figure 11. Sidecast Waste Damage

All steep slopes give potential to incur soil and water damage from sidecasting of surplus excavation waste. While the soils in their undisturbed state may be stable, the soils in sidecast waste are in a loosened state and easily move downslope on steep slopes. The material continually ravels, erodes, and is difficult to stabilize. Downslope movement may extend for a considerable distance, and that which reaches streams has the potential for causing damage to both water quality and fisheries. One good feature here is the culvert downspout.

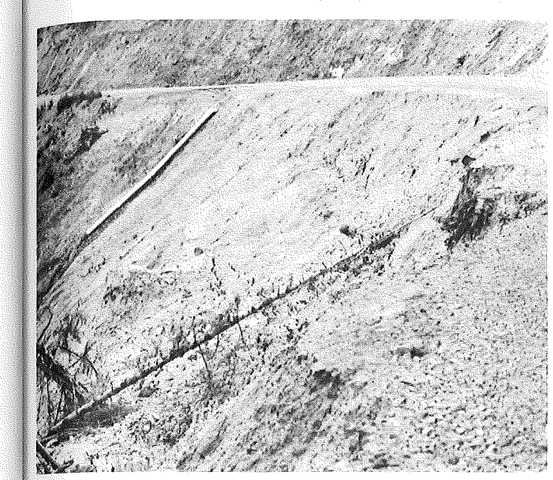


Figure 12.

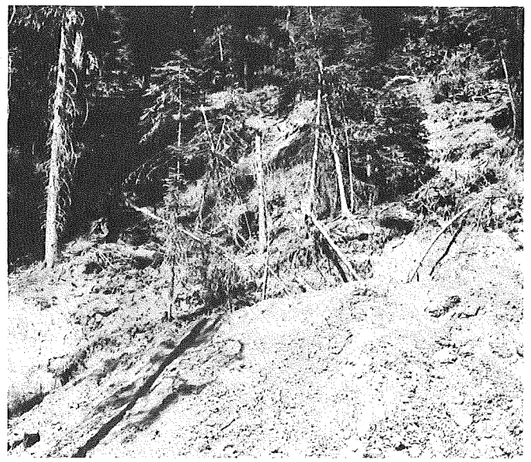


Figure 13.

(Damage Caused by Roads on Unstable Soils)

The potential impact upon soil and water values from road construction is greatly increased on unstable soils like 38 and 46. Sidecast waste is often especially damaging, because in addition to the raveling and eroding that occurs on steep, stable landforms, it may cause overloading of the fill slopes, resulting in large fill slope failures (Figure 12). Much upslope damage is often caused by the road excavation. Support is removed from unstable materials present above the road. Cutslope failures occur (Figure 13), and there is potential for an occasional massive failure (50 cubic yards or more).

Some Suggested Land Management Practices Involving Roads

Certain kinds of practices have been observed to minimize the damage caused to soil and water resources from roads on steep slopes. Some of these are as follows:

1. Because of the ease with which loosened materials tend to move downslope on steep sideslopes, road designs which keep excavation quantities to the absolute minimum help provide protection to the soil and water resources. Minimum road widths and increased allowable grades locally, are two practices which would contribute effectively to this end.

2. The adverse impacts to soil and water resources from sidecast waste can often be reduced by end hauling.

3. One method of treatment on steep road fills and wasteslopes that has been observed to ensure better seeding success, is to install small terraces prior to seeding. This provides a catch area for seed and helps control soil raveling while the grass is becoming established.

MAPPING UNIT DESCRIPTIONS

and

INTERPRETATIVE DISCUSSIONS

DEFINITIONS OF MAPPING UNITS

This section defines the numbers and symbols found on the soil maps. The numbers identify mapping units. The symbols represent land features which are too small to delineate, but are important in land management. The symbols used in this survey are listed below:



Rock outcrop

Talus

Unstable area

Wet spot and small marshes

Slump or slide scarp

Slump

Modal site location

Sample location

Avalanche or debris slide track

Mapping Units [1/] are shown on the soil maps as numbers. Mapping units contain a dominant soil which accounts for at least 70 percent of the soil delineation.

The dominant soil of the mapping unit is described in the mapping unit description and identified by the same number as used for the mapping unit. Within the mapping unit, other soils occur. Those most commonly associated with the dominant soil of the mapping unit are included in the descriptions as inclusions. These inclusions of other soils account for no more than 30 percent of the mapping unit.

The management interpretations presented in the Atlas apply only to the dominant soil in each mapping unit. The interpretations for most inclusions within any mapping unit are listed on the interpretative tables according to the appropriate soil number. The Tables of Some Mapping Unit Characteristics, Features and Qualities, and Table of Bedrock Characteristics of Mapping Units are also numbered according to the dominant soil in the mapping unit and apply to that dominant soil.

1/ Mapping units contain a dominant taxonomic unit.

Mapping Unit Complexes - Many symbols shown on the maps have three digits and are called "Mapping Unit Complexes." These are mapping units used in areas where two defined mapping units are present in an arrangement too complex to separate at the one-inch per mile scale. The following legend indicates the mapping unit components of the complex and the percentage of each component. For example, Mapping Unit Complex 378 is composed of approximately 60 percent Mapping Unit 37 and 40 percent Mapping Unit 38. Refer to each mapping unit description for the soil, bedrock, landform characteristics and key management discussions, and to Tables for the tabular interpretative information.

LEGEND OF COMPLEXES

Mapping Unit Number	Mapping Unit Components
334	50 percent Unit 33 and 50 percent Unit 34
378	60 percent Unit 37 and 40 percent Unit 38
424	50 percent Unit 42 and 50 percent Unit 44
435	50 percent Unit 43 and 50 percent Unit 45
505	60 percent Unit 50 and 40 percent Unit 5
536	60 percent Unit 52 and 40 percent Unit 36
537	60 percent Unit 53 and 40 percent Unit 37
552	60 percent Unit 52 and 40 percent Unit 50
553	60 percent Unit 53 and 40 percent Unit 50
554	60 percent Unit 54 and 40 percent Unit 50
555	60 percent Unit 55 and 40 percent Unit 50
557	60 percent Unit 55 and 40 percent Unit 37
605	60 percent Unit 60 and 40 percent Unit 5
621	60 percent Unit 62 and 40 percent Unit 61
625	60 percent Unit 62 and 40 percent Unit 15
643	50 percent Unit 66 and 50 percent Unit 43
661	60 percent Unit 61 and 40 percent Unit 60
662	60 percent Unit 62 and 40 percent Unit 60

LEGEND OF COMPLEXES

Mapping Unit Number	Mapping Unit Components
663	60 percent Unit 63 and 40 percent Unit 60
664	50 percent Unit 66 and 50 percent Unit 14
665	50 percent Unit 64 and 50 percent Unit 65
710	60 percent Unit 71 and 40 percent Unit 70
720	60 percent Unit 72 and 40 percent Unit 70
805	60 percent Unit 80 and 40 percent Unit 5
813	60 percent Unit 81 and 40 percent Unit 13
823	60 percent Unit 82 and 40 percent Unit 13
827	60 percent Unit 82 and 40 percent Unit 27
835	60 percent Unit 83 and 40 percent Unit 75
881	60 percent Unit 81 and 40 percent Unit 80
882	60 percent Unit 82 and 40 percent Unit 80
883	60 percent Unit 83 and 40 percent Unit 80
915	60 percent Unit 91 and 40 percent Unit 15
991	60 percent Unit 91 and 40 percent Unit 90
992	60 percent Unit 92 and 40 percent Unit 90

Key to Mapping Units - This key is designed to aid the user in determining the relationships and differences between mapping units.

KEY TO MAPPING UNITS

Depth of Soil Materials is 12 feet or Greater

	Type of Material				Dominant Profile Texture Class					Percent Slope			Drainage Class					Natural Stability				
Soil Unit	Alluvial	Till and Glacial Drift	Colluvial and Glacial Drift	Residuum	Coarse	Moderately Coarse	Medium	Moderately Fine	Fine	Less than 35%	Greater than 35%	Other %	Excessively	Well	Moderately Well	Imperfectly	Poorly	I	II	III	IV	V
10	X				X							0-10		←	→			X				
11		X			X							0-15	X					X				
12 1/		X			←	→				X				X				←	→			
13 1/		X			←	→					X			X					X			
14 2/		X			←	→				X				X				←	→			
15 2/		X			←	→					X			X					X			
26			X				←	→		X				←	→			←	→			
27			X				←	→			X			←	→				←	→		
44 3/				X				←	→	X					←	→			←	→		
45 3/				X				←	→	X					←	→			←	→		
46				X					X			20-50				←	→					X

1/ Mapping Units 12 and 13 are noncompact to weakly compact soils with overstory vegetation consisting of Ponderosa pine stands or mixed stands of Ponderosa pine and Douglas-fir.

2/ Mapping Units 14 and 15 are moderately compact to weakly compact soils; local strong compaction occurs. The overstory vegetation is slow growing stands of alpine fir and silver fir at the highest elevations grading to low site stands of mixed conifers at lower elevations.

3/ Mapping Unit 44 supports Ponderosa pine and Douglas-fir stands. Mapping Unit 45 supports mixed conifer stands.

KEY TO MAPPING UNITS (CONT.)

Soils Associated with Bedrock At Less Than 12 Feet

Bedrock	Soil Unit	Depth of Soil to Bedrock: Rock Outcrop	Shallow	Moderately Deep	Deep	Very Deep	Dominant Profile Texture Class: Coarse	Moderately Coarse	Medium	Moderately Fine	Fine	Landform: Steep, smooth, stable sideslopes of greater than 35 percent slope	Steep, highly dissected, stable sideslopes of greater than 35percent slope	Steep, unstable sideslopes of greater than 35 percent slope	Smooth, stable landforms of less than 35 percent slope	Overstory Vegetation: Alpine species	Mixed Conifers	P. Pine/Douglas-fir	Open P. Pine, grass& brush	Bunchgrass and brush	Natural Stability: I	II	III
Pyroclastic Rocks	31		←	→				←	→			X						X				←	→
	32		←	→				←	→			X					X					←	→
	33		←	→				←	→				X					X				←	→
	34			X					→				X				X					←	→
	36			←	→				→			X						X					X
	37			←	→				→			X					X						X
	38			←	→				→					X			X						
	42			←	→			←	→						X			X				X	
	43			←	→			←	→						X		X					X	
Mixed Pyroclastic Andesite and Basalt Rocks	50	X																				X	
	52		←	→					X			X						X				X	
	53		←	→					X			X					X					X	
	54		X						X				X					X				←	→
	55		X						X				X				X					←	→
Andesite and Basalt Rocks	60	X																				X	
	61		←	→					X			X							←	→		X	
	62		←	→					X			X					←	→				X	
	63		←	→					X			X				X						X	
	64		X						X						X					X	X		
	65		←	→				←	→						X			X			X		
	66		←	→				←	→						X		X				X		
	67		←	→				←	→						X	X					X		
Nonmarine Sedimentary Rocks	70	X																				X	
	71		X						←	→		X					X					←	→
	72		←	→					←	→				X			X						→
	75				←	→				←	→			X			X						
	76		←	→					←	→					X		X					←	→
Marine Sedimentary Rocks	80	X																				X	
	81		←	→				←	→			X						X				X	
	82		←	→				←	→			X					X					X	
	83		←	→				←	→				X				X					←	→
Metamorphic and Intrusive Igneous Rocks	90	X																				←	→
	91		←	→				←	→			X					X					X	
	92		←	→				←	→				X				X					←	→

MAPPING UNIT DESCRIPTIONS AND SOIL MANAGEMENT INFORMATION

This section contains descriptions and some soil management information for the Mapping Units.

Most of the Mapping Units are described in detail. These soils have a definable range of characteristics that can be represented by a soil profile description. The dominant soils of Mapping Unit 1 through 9 are either limited in extent or quite variable in composition, and have not been described in detail. Mapping Units 50, 60, 70, 80 and 90 are rock outcrop and also have not been described in detail. These fourteen mapping units are described in a short narrative.

Information in Mapping Unit Descriptions

The first paragraph states the primary soil and the most common inclusions found within the mapping unit. The second paragraph indicates which mapping units are similar to the one being described. The third paragraph gives a brief generalized description of the primary soil. The fourth paragraph briefly describes the bedrock occurring in the mapping unit. The fifth paragraph describes landform, elevation ranges and vegetative characteristics. It further states the soil drainage class and permeability. Reference should be made to Appendix VI for definition of terms used in these descriptions.

Range of Profile Characteristics

This describes the range of soil profile characteristics that have been established for the dominant soil within the mapping unit.

Soil Management Information

This gives information on primary soil interpretations and limitations, and discusses the relative impact to soils and water from certain management practices. Only the most important and pertinent interpretations and limitations are given. If an item such as regeneration potential is not recorded for a given mapping unit, then there is no particular soil limitation.

MAPPING UNIT DESCRIPTIONS 1/

Mapping Unit 1 - High-elevation meadowlands with low-site timber. This mapping unit is found primarily along the Cascade Crest. Soils are generally coarse textured and shallow (commonly 1-4 feet), over hard andesite and basalt. The bedrock is competent with few fractures. Meadows are numerous throughout these flats where the slope rarely exceeds 20 percent. The most common inclusion is Soil 6. (Refer to Land Area A for management discussion.)

Mapping Unit 2 - Dry Meadows. This mapping unit consists of deep to very deep soils. The surface soils are generally thin, moderately coarse to medium textured, well structured and high in organic matter. The subsoils are generally thick and range from medium to moderately fine texture. These soils are well to moderately well drained. Slopes range from 0 to 35 percent. Grasses are the primary vegetation. The most common inclusion is Soil 3.

Mapping Unit 3 - Marshland and wet meadows. This mapping unit consists of depressional areas that are seasonably ponded. The soils are slowly permeable, imperfectly to poorly drained, and normally support sedges, rushes, grasses and willow. The most common inclusions are Soils 12, 14, 44, 45, 46, 66 and 67.

Mapping Unit 4 - Gently sloping talus slopes. This mapping unit consists of deep colluvial and residual boulder deposits in valley bottoms and on slopes of less than 35 percent. It is barren of vegetation. The most common inclusion is Soil 5.

Mapping Unit 5 - Steep talus slopes. This mapping unit consists of colluvial bouldery sideslopes of greater than 35-percent slope. This mapping unit is devoid of vegetation. Common inclusions are Soils 4, 6, 7, 8, 50, 60, 70 and 90.

Mapping Unit 6 - Rock outcrop, talus and meadows. This mapping unit consists primarily of rock outcrop, talus and meadows. Soils occur intermittently and are very shallow gravelly loams or sandy loams. This mapping unit occurs on high-elevation ridgetops and cirque topography. Perpetual snow and ice occur in the Goat Rock area. Bedrock is hard andesites, breccias or granitics. Slopes range from 20 to greater than 100 percent. (Refer to Land Area A for management discussion.)

1/Mapping Units 1 through 9 and 50, 60, 70, 80 and 90 are miscellaneous units and are not described in detail.

Mapping Unit 7 - Rugged, rocky landforms with low-site timber. This mapping unit consists of rock outcrop, talus slopes and avalanche tracks. Soils are generally shallow (commonly 1-4 feet), gravelly, moderately coarse to medium textured, and support Site Class V Douglas-fir or true fir, and noncommercial timber. This mapping unit occurs on ridgetops, cirque basins and upper sideslopes. Severe management problems occur because of topographic and climatic limitations. Slopes generally range from 50 to greater than 100 percent. (Refer to Land Area A for management discussion.)

Mapping Unit 8 - Highly dissected landforms with low-site timber. This mapping unit consists of an intense pattern of parallel stream dissections, long, narrow talus slopes, and/or avalanche tracks. Soils are generally shallow (1-4 feet), and gravelly moderately coarse-textured that generally support Site Class IV and V Douglas-fir or true fir. This mapping unit is better-timbered than Mapping Unit 7, but has severe management problems because of the dissections and/or avalanche tracks. Slopes generally range from 50 to 90 percent. (Refer to Land Area A for management discussion.)

Mapping Unit 9 - Steep, barren slide areas. This mapping unit consists of very steep and barren landslide slopes. The bedrock is generally soft. (Refer to Land Area C for management discussion.)

MAPPING UNIT 10

Mapping Unit 10 consists of Soil 10 and inclusions of other soils. The most common inclusion is Soil 12.

Soil 10 is a very deep, nonplastic soil derived from alluvium. Surface soils are generally thin gravelly loamy sands. Subsoils are generally very thick, very gravelly and cobbly sand.

Bedrock is igneous, sedimentary or pyroclastic rock and occurs 12 feet or more beneath the soil surface.

Typically, Soil 10 occurs on river and stream flood plains. This soil ranges in elevation from 1,800 to 3,500 feet and supports Douglas-fir, ponderosa pine, cottonwood and cedar. This soil is well to moderately well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 10

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface-Layers - Dark brown to yellowish brown gravelly loamy sand, ranging to gravelly sandy loam; single-grained; 25 to 45 percent subround to round gravel by volume; nonsticky, nonplastic; *pH ranges from 5.0 to 5.5. 8 to 24 inches thick.

Subsoil Layers - Dark yellowish brown to brown mixed sands, rounded gravel, cobbles and stones; nonsticky, nonplastic; pH ranges from 5.5 to 6.0. 120 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 10 has the following important limitations and interpretations:

Recreation

1. Suitability for Recreation Area Development - This soil has moderate suitability for recreation area development. Limitations are caused by the periodic occurrence of high water tables and from the hazard of local annual flooding.

2. Suitability for Sewage Filter Field - This soil has poor suitability. Hazards of local flooding, high water tables and rapidly permeable subsoils create high potential for contamination of ground water and adjacent streams.

* All pH values shown on these mapping unit descriptions were taken by the Hellige-Truog or Oregon State University test methods.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods

a. Tractor - Low to moderate soil damage can be caused by tractor logging. Damage can result from tractor turning, and blade and log gouging that may cause soil loosening and displacement. The amount of damage depends upon such factors as wetness, frequency of tractor passes, and the care and skill of the tractor operator.

b. Partially Suspended Cable System - Minimal soil damage would be expected with this system.

MAPPING UNIT 11

Mapping Unit 11 consists of Soil 11 and inclusions of other soils. The most common inclusion is Soil 14.

Mapping Unit 11 is similar to Mapping Units 12 and 14 with the exception of vegetation, drainage and inclusions.

Soil 11 is a very deep, nonplastic soil derived from glacial outwash. Surface soils are generally thin gravelly loamy sands. Subsoils are generally very thick, very gravelly sands.

Bedrock is igneous rock and occurs 12 feet or more beneath the soil surface.

Typically, Soil 11 occurs on valley terraces of less than 15-percent slope. This soil ranges in elevation from 3,000 to 3,500 feet and supports western larch, western white pine and lodgepole pine. This soil is excessively drained. Permeability is very rapid.

Range of Profile Characteristics of Soil 11

Litter - Needles, leaves, twigs and decomposing organic matter. 0 to 1 inch thick.

Surface Layers - Dark grayish brown to brown gravelly sandy loam to gravelly loamy sand; single-grained; 25 to 40 percent subround gravel and cobbles by volume; nonsticky, nonplastic; pH ranges from 5.5 to 6.0. 12 to 30 inches thick.

Subsoil Layers - Brown to dark brown, extremely gravelly and cobbly sand; single-grained; 70 to 90 percent subround or round gravel, cobbles and stones by volume; nonsticky, nonplastic; pH ranges from 5.0 to 5.5. 114 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 11 has the following important limitations and interpretations:

Recreation

1. Suitability for Recreation Area Development

   This soil is generally well suited.

2. Suitability for Sewage Filter Field - This soil is generally well suited on slopes of less than 10 percent. However, because these soils are coarse-textured and highly permeable, the effluent may travel some distance through the soils prior to becoming adequately filtered. Because of this it is advisable to locate well away from streams or ponds.

Timber Management

Limitations to Regeneration and Tree Growth - This soil has limitations that affect regeneration and growth. Limitations are caused by coarse-textured, excessively drained soils that have very limited moisture-holding capacity. Other factors of low fertility and frost heave contribute to limited regeneration success, especially that of Douglas-fir.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods

a. Tractor - The potential impact is relatively low. Some soil damages can result from tractor turning, and blade and log gouging that may cause soil loosening and displacement. The amount of damage depends to a large extent upon the care and skill of the tractor operator.

b. Partially Suspended Cable System - Only minimal soil damage would be expected with this system.

MAPPING UNIT 12

Mapping Unit 12 consists of Soil 12 and inclusions of other soils. The most common inclusions are Soils 10, 13 and 14.

Mapping Unit 12 is similar to Mapping Unit 13 with the exception of landform and inclusions, and Mapping Unit 14 with the exception of vegetation and inclusions.

Soil 12 is a very deep, nonplastic soil derived from glacial drift. Surface soils are generally thin sandy loams. Subsoils are generally very thick, very gravelly loamy sands.

Bedrock is igneous, sedimentary or pyroclastic rock and occurs 12 feet or more beneath the soil surface.

Typically, Soil 12 occurs on glacially modified valley bottoms and toeslopes of less than 35-percent slope. This slope ranges in elevation from 1,800 to 3,500 feet and supports Douglas-fir along with ponderosa pine, western redcedar, and mountain hemlock. This soil is well drained. Permeability is rapid in the surface soils and rapid to moderately rapid in the subsoils.

Range of Profile Characteristics of Soil 12

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 2 inches thick.

Surface Layers - Very dark brown to dark yellowish brown sandy loam to loam; weak, fine, subangular blocky structure; 20 to 35 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 5.0 to 6.0. 8 to 36 inches thick.

Subsoil Layers - Very dark brown to strong brown very gravelly loamy sand to very gravelly sandy loam; single-grained; 50 to 75 percent subangular gravel and cobbles by volume; noncompact to weakly compact; nonsticky, nonplastic; pH ranges from 5.5 to 6.5. 108 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 12 has the following important limitations and interpretations:

Recreation

1. Suitability for Recreation Area Development - This soil has moderate suitability. Some limitations are present in this mapping unit because of the local occurrence of wet spots.

2. Suitability for Sewage Filter Field - This soil is well suited except in and near wet spots.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - The potential impact is relatively low. Some soil damage can result from tractor turning, and blade and log gouging that may cause soil loosening and displacement. The amount of damage depends to a large extent upon the care and skill of the tractor operator.

   b. Partially Suspended Cable System - Only minimal soil damage would be expected with this system.

MAPPING UNIT 13

Mapping Unit 13 consists of Soil 13 and inclusions of other soils. The most common inclusions are Soils 15 and 12.

Mapping Unit 13 is similar to Mapping Unit 12 with the exception of landform and inclusions and Mapping Unit 15 with the exception of vegetation and inclusions.

Soil 13 is a very deep, nonplastic soil derived from glacial drift. Surface soils are generally thin sandy loams. Subsoils are generally very thick, very gravelly loamy sands.

Bedrock is igneous, sedimentary or pyroclastic rock and occurs 12 feet or more beneath the soil surface.

Typically, Soil 13 occurs on glacial valley sideslopes of greater than 35-percent slope. This soil ranges in elevation from 1,800 to 3,500 feet and supports Douglas-fir along with ponderosa pine, western redcedar and mountain hemlock. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 13

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 2 inches thick.

Surface Layers - Very dark brown to dark yellowish brown sandy loam to loam; weak, fine, subangular blocky structure; 20 to 35 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 5.0 to 6.0. 8 to 36 inches thick.

Subsoil Layers - Very dark brown to strong brown, very gravelly loamy sand to very gravelly sandy loam; single-grained; 50 to 75 percent subangular gravel and cobbles by volume; noncompact to weakly compact; nonsticky, nonplastic; pH ranges from 5.5 to 6.5. 108 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 13 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally too steep (greater than

35 percent) to be tractor operable without the risk of causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - The potential for soil damage is low to moderate depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices - Roads have a low to moderate potential impact on soil and water values, with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 14

Mapping Unit 14 consists of Soil 14 and inclusions of other soils. The most common inclusions are Soils 15, 12 and 43.

Mapping Unit 14 is similar to Mapping Unit 15 with the exception of landform and inclusions, and Mapping Unit 12 with the exception of vegetation and inclusions.

Soil 14 is a very deep, nonplastic soil derived from glacial till. Surface soils are generally thin sandy loams. Subsoils are generally very thick, weakly to moderately compact, gravelly sandy loams or very gravelly loamy sands.

Bedrock is igneous or pyroclastic rock and occurs 12 feet or more beneath the soil surface.

Typically, Soil 14 occurs on valley bottoms and toeslopes of less than 35-percent slope. This soil ranges in elevation from 3,500 to 6,500 feet and supports Douglas-fir along with white fir, western larch, mountain hemlock and true fir. This soil is well drained. Permeability is rapid in the surface soils and moderate to slow in the subsoils.

Range of Profile Characteristics of Soil 14

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 2 inches thick.

Surface Layers - Very dark brown to strong brown sandy loam to gravelly loamy sand; single-grained; 20 to 40 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 5.5 to 6.5. 12 to 24 inches thick.

Subsoil Layers - Brown to light yellowish brown gravelly sandy loam to gravelly loamy sand; massive; 40 to 60 percent subangular gravel and cobbles by volume; weakly to moderately compact; nonsticky to slightly sticky, nonplastic; pH ranges from 5.0 to 6.0. 120 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 14 has the following important limitations and interpretations:

Recreation

1. Suitability for Recreation Area Development - This soil has moderate suitability. Limitations result from local restricted drainage because of compacted subsoils.

2. Suitability for Sewage Filter Field - Slopes under 10 percent vary in suitability from moderate to poor. Limitations are caused by drainage restrictions, the local occurrence of high water tables and/or the proximity to streams that may become polluted. Slopes in excess of 10 percent are poorly suited because of steepness.

Timber Management

1. Limitations to Regeneration and Tree Growth - Limitations are present that adversely affect regeneration and tree growth, especially Douglas-fir. This soil occurs in higher-elevation valley bottoms that are subject to heavy snows and cold air drainage. This causes limitations of short growing season, cold soils and frost heave. Cold soil temperatures occur during part of the growing season which causes slow microbiological activity, resulting in slow nutrient release. This limits growth and affects regeneration.

   Planting success is related to soil temperatures. The most favorable soil conditions generally occur some time after the spring snowmelt when soil temperatures begin warming and the soil moisture supply is still adequate.

2. Planting Species - Soil and climatic factors, along with observations, indicate that true fir or larch plantings are better adapted than Douglas-fir and would require less intensive management to ensure survival and growth.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - The potential impact is relatively low. Some soil damage can result from tractor turning and blade and log gouging that may cause soil loosening and displacement. The amount of damage depends upon such factors as wetness, frequency of tractor passes, and the care and skill of the tractor operator.

   b. Partially Suspended Cable System - Only minimal soil damage would be expected with this system.

MAPPING UNIT 15

Mapping Unit 15 consists of Soil 15 and inclusions of other soils. The most common inclusions are Soils 14, 13, 53, 63 and 91.

Mapping Unit 15 is similar to Mapping Unit 14 with the exception of landform and inclusions, and to Mapping Unit 13 with the exception of vegetation and inclusions.

Soil 15 is a very deep, nonplastic soil derived from glacial till. Surface soils are generally thin sandy loams. Subsoils are generally very thick, weakly to moderately compact, gravelly sandy loams or very gravelly loamy sands.

Bedrock is igneous or pyroclastic rock and occurs 12 feet or more beneath the soil surface.

Typically, Soil 15 occurs on steep, smooth, nondissected to moderately dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,500 to 6,500 feet and supports Douglas-fir along with white fir, western larch, mountain hemlock and true fir. This soil is well drained. Permeability is rapid in the surface soils and moderate to slow in the subsoils.

Range of Profile Characteristics of Soil 15

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 2 inches thick.

Surface Layers - Very dark brown to strong brown sandy loam to gravelly loamy sand; single-grained; 20 to 40 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 5.5 to 6.5. 12 to 24 inches thick.

Subsoil Layers - Brown to light yellowish brown gravelly sandy loam to gravelly loamy sand; massive; 40 to 60 percent subangular gravel and cobbles by volume; weakly to moderately compact; nonsticky to slightly sticky, nonplastic; pH ranges from 5.0 to 6.0. 120 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 15 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Timber Management

1. Limitations to Regeneration and Tree Growth - Limitations are present that adversely affect regeneration and tree growth, especially Douglas-fir. This soil occurs in higher-elevation valley toeslopes and sideslopes. Heavy snows and cold temperatures result in short growing seasons. Cold soil temperatures occur during portions of the growing season which causes limited microbiological activity, resulting in slow nutrient release. This limits growth and affects regeneration.

   Planting success is related to soil temperatures. The most favorable soil conditions generally occur some time after the spring snowmelt when soil temperatures begin warming and the soil moisture supply is still adequate.

2. Planting Species - Soil and climatic factors, along with observations, indicate that true fir or larch plantings are better adapted than Douglas-fir and would require less intensive management to ensure survival and growth.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally too steep (greater than 35 percent) to be tractor operable without the potential of causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - The potential for soil damage is low to moderate depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under engineering practices.

2. Engineering Practices

   Roads have a low to moderate potential impact on soil and water values, with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion of cutbanks often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 26

Mapping Unit 26 consists of Soil 26 and inclusions of other soils. The most common inclusions are Soils 27 and 12.

Mapping Unit 26 is similar to Mapping Unit 27 with the exception of landform and inclusions.

Soil 26 is a very deep, slightly plastic soil derived from colluvium. Surface soils are generally thin loams. Subsoils are generally very thick gravelly silt loams.

Bedrock is sedimentary and occurs 12 feet or more beneath the soil surface.

Typically, Soil 26 occurs on somewhat uneven slopes of less than 35-percent slope. This soil ranges in elevation from 3,000 to 4,500 feet and supports Douglas-fir, ponderosa pine, white fir and western larch. This soil is well to moderately well drained. Permeability is rapid in the surface soils and rapid to moderately rapid in the subsoils.

Range of Profile Characteristics of Soil 26

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface Layers - Dark yellowish brown to brown sandy loam, ranging to loam; weak, fine, subangular blocky structure; 10 to 30 percent subangular gravel by volume; nonsticky, nonplastic; pH ranges from 5.0 to 5.5. 8 to 24 inches thick.

Subsoil Layers - Dark yellowish brown to yellowish brown gravelly silt loam to gravelly loam; massive; 35 to 50 percent subangular gravel and cobbles by volume; slightly sticky, slightly plastic; pH ranges from 5.5 to 6.0. 120 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 26 has no severe limitations or major interpretations as related to management activities.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods

a. Tractor - There is potential for moderate damage from tractor logging, especially if soils are wet. Tractor turning and blade and log gouging may destroy protective duff cover, loosen and displace soil, destroy soil structure, and may cause local soil compaction. The potential for erosion and stream sedimentation is increased and a loss of productivity may result. Compaction may be locally severe during wet conditions. Compacted soils

adversely affect growth by restricting water infiltration, root penetration, and soil aeration.

b. Partially Suspended Cable System - Only minimal soil damage would be expected with this system.

MAPPING UNIT 27

Mapping Unit 27 consists of Soil 27 and inclusions of other soils. The most common inclusions are Soils 26, 81, 82 and 75.

Mapping Unit 27 is similar to Mapping Unit 26 with the exception of landform and inclusions.

Soil 27 is a very deep, slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin loams. Subsoils are generally very thick gravelly silt loams.

Bedrock is sedimentary and occurs 12 feet or more beneath the soil surface.

Typically, Soil 27 occurs on steep, smooth, slightly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 4,500 feet and supports Douglas-fir, ponderosa pine, white fir and western larch. This soil is well to moderately well drained. Permeability is rapid in the surface soils and rapid to moderately rapid in the subsoils.

Range of Profile Characteristics of Soil 27

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface Layers - Dark yellowish brown to brown sandy loam, ranging to loam; weak, fine, subangular blocky structure; 10 to 30 percent subangular gravel by volume; nonsticky, nonplastic; pH ranges from 5.0 to 5.5. 8 to 24 inches thick.

Subsoil Layers - Dark yellowish brown to yellowish brown gravelly silt loam to gravelly loam; massive; 35 to 50 percent subangular gravel and cobbles by volume; slightly sticky, slightly plastic; pH ranges from 5.5 to 6.0. 120 inches thick or greater.

Some Important Soul Limitations and Interpretations

Soil 27 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Engineering

Erosion on Road Waste and Fills - Road waste and fill slopes are potentially highly erosive on this soil.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally much too steep (greater than 35 percent) to be tractor operable without having the potential to incur excessive soil damage. Soil damage from tractor logging may result in surface soil loosening, displacement, and compaction that impedes water infiltration and reduces the soil water storage capacity. Also, there is increased susceptibility for severe erosion by exposing bare soil and producing areas for water to be accumulated and run over the surface.

   b. Partially Suspended Cable System - This soil has the potential to incur moderate soil damage from this method. The extent of actual damage incurred depends upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

   Roads have a low to moderate potential impact on soil and water values, with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion of cutbanks often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 31

Mapping Unit 31 consists of Soil 31 and inclusions of other soils. The most common inclusions are Soils 32, 36 and 52.

Mapping Unit 31 is similar to Mapping Unit 32 with the exception of vegetation and inclusions, and to Mapping Unit 52 with the exception of bedrock and inclusions.

Soil 31 is a shallow to moderately deep (commonly 2-5 feet), nonplastic to slightly plastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly silt loam or gravelly loams.

Bedrock is composed of moderately competent, highly to moderately fractured pyroclastic rock.

Typically, Soil 31 occurs on steep, nondissected to slightly dissected sideslopes of greater than 35-percent slope.

This soil ranges in elevation from 1,800 to 4,000 feet and supports ponderosa pine and Douglas-fir. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 31

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 2 inches thick.

Surface Layers - Brown to dark brown sandy loam ranging to loam; single-grained; 10 to 35 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 4.5 to 5.5. 12 to 30 inches thick.

Subsoil Layers - Dark yellowish brown to very pale brown gravelly silt loam ranging to gravelly sandy loam; 30 to 50 percent subangular gravel and cobbles by volume; slightly sticky to nonsticky, slightly plastic to nonplastic; pH ranges from 5.0 to 6.0. 12 to 30 inches thick.

Some Important Soil Limitations and Interpretations

Soil 31 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally much too steep (greater than 35 percent) to be tractor operable without the potential for causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - The potential for soil damage is low to moderate depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices - Roads have a low to moderate potential impact on soil and water values, with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 32

Mapping Unit 32 consists of Soil 32 and inclusions of other soils. The most common inclusions are Soils 31, 37 and 53.

Mapping Unit 32 is similar to Mapping Unit 31 with the exception of vegetation and inclusions, and to Mapping Unit 53 with the exception of bedrock and inclusions.

Soil 32 is a shallow to moderately deep (commonly 2-5 feet), nonplastic to slightly plastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly silt loams or gravelly loams.

Bedrock is composed of moderately competent, highly to moderately fractured pyroclastic rock.

Typically, Soil 32 occurs on steep, nondissected to slightly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 6,000 feet and supports Douglas-fir, western larch and true fir. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 32

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 2 inches thick.

Surface Layers - Brown to dark brown sandy loam ranging to loam; single-grained; 10 to 35 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 4.5 to 5.5. 12 to 24 inches thick.

Subsoil Layers - Dark yellowish brown to very pale brown gravelly silt loam ranging to gravelly sandy loam; 30 to 50 percent subangular gravel and cobbles by volume; slightly sticky to nonsticky, slightly plastic to nonplastic; pH ranges from 5.0 to 6.0. 12 to 36 inches thick.

Some Important Soil Limitations and Interpretations

Soil 32 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally too steep (greater than 35 percent) to be tractor operable without the risk of causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - The potential for soil damage is low to moderate depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices - Roads have a low to moderate potential impact on soil and water values, with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 33

Mapping Unit 33 consists of Soil 33 and inclusions of other soils. The most common inclusions are Soils 34 and 42.

Mapping Unit 33 is similar to Mapping Unit 34 with the exception of vegetation and inclusions.

Soil 33 is a shallow to moderately deep (commonly 2-5 feet), nonplastic to slightly plastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly loams or gravelly silt loams.

Bedrock is composed of soft, moderately competent water-laid pyroclastic rock.

Typically, Soil 33 occurs on steep, highly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 2,300 to 3,600 feet and supports ponderosa pine and Douglas-fir. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 33

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1 inch thick.

Surface Layers - Dark grayish brown to dark yellowish brown sandy loam ranging to loam; weak, fine subangular blocky structure; 10 to 35 percent subangular gravel by volume; nonsticky, nonplastic; pH ranges from 5.0 to 6.0. 8 to 24 inches thick.

Subsoil Layers - Dark yellowish brown to yellowish brown gravelly sandy loam ranging to gravelly silty clay loams; massive; 30 to 50 percent gravel and cobbles by volume; nonsticky to sticky, nonplastic to slightly plastic; pH ranges from 5.5 to 6.5. 16 to 36 inches thick.

Some Important Soil Limitations and Interpretations

Soil 33 has the following important limitations and interpretations:

Watershed

1. Surface Erosion - This soil has the potential for severe erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.") On this soil the erosion problems are increased by the steep and highly dissected nature of the topography.

2. Stream Damage Potential - Because of the steep and highly dissected topography, there is ample opportunity for road waste and harvest slash to enter into the sideslope drainage channels. This material may be periodically flushed out and may contribute debris and sediment to the major streams.

Timber Management

1. Limitations to Regeneration and Tree Growth are caused by relatively coarse-textured soils that occur on south-facing slopes. Summer soil temperatures become very high and available soil moisture becomes critical. These limitations would be expected to have the greatest effect on Douglas-fir regeneration. The amount of moisture in the soil at the time of planting is especially important.

2. Planting Species - Soil and climatic factors, along with observations, indicate that ponderosa pine plantings are better adapted than Douglas-fir and would require less intensive management to ensure survival and growth.

Engineering

1. Susceptibility to Cutbank Sloughing and Raveling - This is a problem on this soil as the exposed cutbanks continually slough and ravel. This requires considerable maintenance and causes potential losses to soil and water values.

2. Soil Limitations for Road Location and Construction - The steep and dissected topography requires considerable excavation and causes poor road alignment. There is a high potential for damages to the soil and water resources from sidecast waste, especially in tributary stream crossings.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is much too steep (greater than 35 percent) to be tractor operable without causing excessive soil damage. Soil damage may result in soil loosening and displacement over wide areas. This greatly increases the susceptibility for severe erosion by exposing bare soils and producing areas for water accumulation and runoff.

   b. Partially Suspended Cable System - This soil has the potential to incur moderate damage from this system. The extent of damage depends upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

   Roads have a moderate to severe potential impact on soil and water values, with the greatest potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries. Additional impacts may be caused to soil and water values from sloughing and raveling on cutslopes.

MAPPING UNIT 34

Mapping Unit 34 consists of Soil 34 and inclusions of other soils. The most common inclusions are Soils 33 and 42.

Mapping Unit 34 is similar to Mapping Unit 33 with the exception of vegetation and inclusions.

Soil 34 is a moderately deep (commonly 3-6 feet), slightly plastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly loams or gravelly silt loams.

Bedrock is composed of soft, moderately competent water-laid pyroclastic rock.

Typically, Soil 34 occurs on steep, highly dissected sideslopes of greater than 35-percent slope.

This soil ranges in elevation from 2,300 to 3,600 feet and supports Douglas-fir, white fir, western larch and ponderosa pine. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 34

Litter	Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.
Surface Layers	Dark grayish brown to yellowish brown gravelly sandy loam ranging to gravelly silty clay loam; weak, fine subangular blocky structure; 15 to 35 percent subangular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 5.5 to 6.5. 12 to 30 inches thick.
Subsoil Layers	Yellowish brown to brown gravelly loam ranging to gravelly silty clay loam; massive; 35 to 50 percent subangular gravel and cobbles by volume; slightly sticky, slightly plastic; pH ranges from 6.0 to 6.5. 24 to 42 inches thick.

Some Important Soil Limitations and Interpretations

Soil 34 has the following important limitations and interpretations:

Watershed

1. Surface Erosion - This soil has the potential for severe erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.") On this soil the erosion problems are increased by the steep and highly dissected nature of the topography.

2. Stream Damage Potential - Because of the steep and highly dissected topography, there is ample opportunity for road waste and harvest slash to enter into the sideslope drainage channels. This material may be periodically flushed out and may contribute debris and sediment to the major streams.

Engineering

1. Susceptibility to Cutbank Sloughing and Raveling - This is a problem on this soil as the exposed cutbanks continually slough and ravel. This requires considerable maintenance and causes potential losses to soil and water values.

2. Soil Limitations for Road Location and Construction - The steep and dissected topography requires considerable excavation and causes poor road alignment. There is a high potential for damages to the soil and water resources from sidecast waste, especially in tributary stream crossings.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is much too steep (greater than 35 percent) to be tractor operable without causing excessive soil damage. Soil damage may result in soil loosening and displacement over wide areas. This greatly increases the susceptibility for severe erosion by exposing bare soils and producing areas for water accumulation and runoff.

   b. Partially Suspended Cable System - This soil has the potential to incur moderate damage from this system. The extent of damage depends upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

   Roads have a moderate to severe potential impact on soil and water values, with the greatest potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries. Additional impacts may be caused to soil and water values from sloughing and raveling on cutslopes.

MAPPING UNIT 36

Mapping Unit 36 consists of Soil 36 and inclusions of other soils. The most common inclusions are Soils 37, 52 and 31.

Mapping Unit 36 is similar to Mapping Unit 37 with the exception of vegetation and inclusions, and to Mapping Unit 42 with the exception of landform and inclusions.

Soil 36 is a moderately deep to deep (commonly 4-10 feet), slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin sandy loams. Subsoils are generally moderately thick to thick gravelly loams or gravelly clay loams.

Bedrock is composed of incompetent, highly fractured and weathered pyroclastic rock.

Typically, Soil 36 occurs on steep, slightly to moderately dissected, somewhat uneven sideslopes of greater than 35-percent slope. This soil ranges in elevation from 1,800 to 4,000 feet and supports ponderosa pine and Douglas-fir. This soil is well to moderately well drained. Permeability is rapid in the surface soils and moderately rapid in the subsoils.

Range of Profile Characteristics of Soil 36

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface Layers - Dark yellowish brown to dark reddish brown gravelly sandy loam ranging to gravelly clay loam; weak, fine, subangular blocky structure; 40 to 55 percent subangular and angular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 5.5 to 6.0. 18 to 30 inches thick.

Subsoil Layers - Dark yellowish brown to yellow gravelly silt loam to gravelly clay loam; massive; 40 to 60 percent subangular and angular gravel and cobbles by volume; slightly sticky, slightly plastic; pH ranges from 5.5 to 6.0. 30 to greater than 90 inches thick.

Some Important Soil Limitations and Interpretations

Soil 36 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Engineering

Susceptibility to Cutbank Sloughing and Raveling - This is a problem on this soil as the exposed cutbanks continually slough and ravel. This requires considerable maintenance and causes potential losses to soil and water values.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is much too steep (greater than 35 percent) to be tractor operable without causing excessive soil damage. Soil damage may result in soil loosening and displacement over wide areas. This greatly increases the susceptibility for severe erosion by exposing bare soils and producing areas for water accumulation and runoff.

b. Partially Suspended Cable System - This soil has the potential to incur moderate damage from this system. The extent of damage depends upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

Roads have a moderate to severe potential impact on soil and water values, with the greatest potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries. Additional impacts may be caused to soil and water values from sloughing and raveling on cutslopes.

MAPPING UNIT 37

Mapping Unit 37 consists of Soil 37 and inclusions of other soils. The most common inclusions are Soils 36, 53, 33 and 38.

Mapping Unit 37 is similar to Mapping Unit 36 with the exception of vegetation and inclusions, and to Mapping Unit 43 with the exception of landform and inclusions.

Soil 37 is a moderately deep to deep (commonly 4-10 feet), slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin sandy loams. Subsoils are generally moderately thick to thick gravelly loams or gravelly clay loams.

Bedrock is composed of incompetent, highly-fractured and weathered pyroclastic rock.

Typically, Soil 37 occurs on steep, slightly to moderately dissected, somewhat uneven sideslopes of greater than 35-percent slope.

This soil ranges in elevation from 3,000 to 6,000 feet and supports Douglas-fir, white fir, western larch, ponderosa pine, mountain hemlock and true fir. This soil is well to moderately well drained. Permeability is rapid in the surface soils and moderately rapid in the subsoils.

Range of Profile Characteristics of Soil 37

Litter - Needles, leaves, twigs, and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark yellowish brown to dark reddish brown gravelly sandy loam, ranging to gravelly clay loam; weak, fine, subangular blocky structure; 40 to 55 percent subangular and angular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 5.5 to 6.0. 18 to 30 inches thick.

Subsoil Layers - Dark yellowish brown to yellow gravelly silt loam to gravelly clay loam; massive; 40 to 60 percent subangular and angular gravel and cobbles by volume; slightly sticky, slightly plastic; pH ranges from 5.5 to 6.0. 30 to greater than 90 inches thick.

Some Important Soil Limitations and Interpretations

Soil 37 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Engineering

1. Susceptibility to Cutbank Sloughing and Raveling - This is a problem on this soil as the exposed cutbanks continually slough and ravel. This requires considerable maintenance and causes potential losses to soil and water values.

2. Soil Limitations for Road Location and Construction - Some instability problems can be expected on this soil, both on cutbanks and fill slopes. There is a high potential for damage to the soil and water resources from sidecast waste, especially in tributary stream crossings.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

a. Tractor - This mapping unit is much too steep (greater than 35-percent) to be tractor operable without causing excessive soil damage. Soil damage may result in soil loosening and displacement over wide areas. This greatly increases the susceptibility for severe erosion by exposing bare soils and producing areas for water accumulation and runoff.

b. Partially Suspended Cable System - This soil has the potential to incur moderate damage from this system. The extent of damage depends upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damages may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

Roads have a moderate to severe potential impact on soil and water values, with the greatest potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries. Additional impacts may be caused to soil and water values from sloughing and raveling on cutslopes.

MAPPING UNIT 38

Mapping Unit 38 consists of Soil 38 and inclusions of other soils. The most common inclusions are Soils 37 and 9.

Mapping Unit 38 is similar to Mapping Unit 75 with the exception of bedrock and inclusions.

Soil 38 is a moderately deep to very deep (4-12 feet plus), plastic soil derived from residuum and colluvium. Surface soils are generally thin silty clay loams or clay loams. Subsoils are moderately thick to very thick clays or clay loams.

Bedrock is soft, incompetent pyroclastic rock and occurs 4 feet or more beneath the soil surface.

Typically, Soil 38 occurs on steep, uneven and highly-dissected sideslopes and drainages of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 6,000 feet and supports Douglas-fir, mountain hemlock, western redcedar, true fir and white fir.

This soil is moderately well to imperfectly drained. Permeability is rapid in the surface soils and slow in the subsoils.

Range of Profile Characteristics of Soil 38

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Yellowish brown to reddish brown clay loam ranging to silt loam; moderate, fine, subangular blocky structure; 5 to 35 percent subangular gravel by volume; sticky to slightly sticky, slightly plastic; pH ranges from 5.5 to 6.0. 8 to 30 inches thick.

Subsoil Layers - Dark grayish brown to reddish brown clay ranging to clay loam; massive; 0 to 25 percent subangular gravel by volume; sticky to very sticky, plastic to very plastic; pH ranges from 5.5 to 6.0. 40 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 38 has several important limitations and interpretations as follows:

Watershed

1. Natural Stability - This soil is unstable in the natural state. The topography shows extensive evidence of past and present failures.

2. Expected Mass Movement as a Result of Man's Activities - The rate of failure is expected to greatly increase over the natural state as a result of road construction and timber harvest activities.

3. Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

4. Sediment Yield Potential - Whenever this soil is exposed, such as in harvest units or on road cutbanks and wasteslopes, it has a high potential to yield sediment of silt and clay to streams. This sediment often remains in water suspension for extended periods and may cause losses to water quality and fisheries.

Engineering

1. Susceptibility to Cutbank Slough and Ravel - This is a severe problem on this soil as the exposed cutbanks continually slough and ravel. This requires frequent maintenance and causes potential losses to soil and water values.

2. Probability of Cutbank Failures - This soil has the probability that 9 to 15 failures of at least 10 cubic yards each will occur per mile. In addition, there is the probability of an occasional failure occurring of 50 cubic yards or more.

3. Failure and Erosion on Road Waste and Fills - This is a severe problem on this soil. When this occurs near streams, it provides sediment that may be damaging to the water resource.

4. Considerations for Road location and Construction - In addition to problems discussed in previous interpretations, all-weather roads on this soil will require relatively thick base coarse and frequent culverts. Proper compaction of fills may be difficult to obtain because of excessive moisture. Cutbank stability control may require measures such as planting willow shoots and/or local installation of horizontal drains and binwalls.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit has very severe soil and slope limitations to be tractor operable without the potential of causing extensive soil damage. Soil damage from tractor logging may result in surface soil loosening, displacement, increased slide activity, and severe compaction that restricts water infiltration, root penetration and soil aeration. Also, there is greatly increased susceptibility for severe surface erosion by exposing bare soils and producing areas for water accumulation and runoff.

   b. Partially Suspended Cable System - This method has the potential for causing severe soil damage. Damage may be caused by logs becoming temporarily airborne prior to slamming into and gouging the soils. This may trigger surface slides and cause soil displacement and compaction that allows soils to be vulnerable to erosion damage. Much of the total damage is related to access roads depending upon their design, location and frequency. Roads have a high impact potential as cutbanks and fillslopes slough, ravel and fail. Roads also increase the potential for an occasional massive failure.

   c. Fully Suspended Cable System - This method may cause moderate soil damage. Although little soil disturbance would be expected from the actual harvest operation, removal of trees may cause changes that would increase future slide activity. Removal of trees reduces evapotranspiration resulting in increased soil water. This reduces internal friction and cohesion which may cause an increase in slump and slide activity. Also, as tree roots decompose, their soil stabilizing effects from soil binding are lost. Also, considerable damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

The soil and water impact from roads can be very severe on this soil. Roads greatly increase the potential for slumps and slides. Cutbanks and wasteslopes slough, ravel, erode and fail, and there is potential for an occasional massive failure. Excavation waste when sidecast causes a severe impact because in addition to sloughing and raveling, it can cause overloading of the wasteslope, resulting in large wasteslope failures. This damages soils and causes potential damage to streams, with loss of water quality and fisheries.

MAPPING UNIT 42

Mapping Unit 42 consists of Soil 42 and inclusions of other soils. The most common inclusions are Soils 43 and 44.

Mapping Unit 42 is similar to Mapping Unit 43 with the exception of vegetation and inclusions, and to Mapping Unit 36 with the exception of landform and inclusions.

Soil 42 is a moderately deep to very deep (5-12 feet plus), nonplastic to slightly plastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are moderately thick to very thick gravelly sandy loam or gravelly silt loams.

Bedrock is composed of moderately competent to incompetent, highly to moderately fractured pyroclastic rock.

Typically, Soil 42 occurs on slightly to moderately dissected, somewhat uneven valley bottoms, toeslopes, terraces and broad ridgetops of less than 35-percent slope. This slope ranges in elevation from 1,800 to 4,000 feet and supports ponderosa pine and Douglas-fir. This soil is well drained. Permeability is rapid in the surface soils and moderately rapid in the subsoils.

Range of Profile Characteristics of Soil 42

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 2 inches thick.

Surface Layers - Dark brown to brown sandy loam ranging to silty clay loam; weak, fine, subangular blocky structure; 10 to 40 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 5.0 to 6.0. 12 to 36 inches thick.

Subsoil Layers - Very dark grayish brown to yellowish brown gravelly clay loam ranging to gravelly sandy loam; massive; 30 to 60 percent subangular gravel and cobbles by volume; slightly sticky to sticky, slightly plastic to plastic; pH ranges from 5.0 to 6.0. 48 to greater than 108 inches thick.

Some Important Soil Limitations and Interpretations

Soil 42 has the following important limitations and interpretations:

Recreation

1. Suitability for Recreation Area Development - This soil has low to moderate suitability. Limitations result from fine textures locally that cause muddiness and restrict drainage.

2. Suitability for Sewage Filter Field - Slopes under 10 percent vary in suitability from poor to moderate. Limitations are caused by fine textures locally in the subsoils that restrict downward drainage and cause the effluent to move laterally. This may appear at the surface or reach bodies of water causing contamination.

Timber Management

1. Limitations to Regeneration and Tree Growth - Limitations to regeneration and tree growth are present, especially along the eastern edge of the Forest where Douglas-fir regeneration can be expected to have very limited success. Limitations are caused by low precipitation, hot summer soil temperatures, south exposures, and competition for moisture from pinegrass and other grasses. The amount of moisture in the soil at the time of planting is especially important.

2. Planting Species - Soil and climatic factors along with observations indicate that ponderosa pine plantings are better adapted to the more droughty conditions than Douglas-fir. Less intensive management would be required to ensure survival and growth.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods

a. Tractor - This soil has the potential to incur moderate damage from this method. Damage can result from tractor turning and blade and log gouging that may cause soil loosening, displacement, and some compaction. Compaction damage may be locally severe during wet conditions. The extent of damage that is actually caused depends upon such factors as soil wetness at the time of operation, frequency of tractor passes, and the care and skill of the tractor operator.

b. Partially Suspended Cable System - The potential impact from this method is relatively low. Some soil damage may result from log skidding and gouging.

MAPPING UNIT 43

Mapping Unit 43 consists of Soil 43 and inclusions of other soils. The most common inclusions are Soils 42 and 45.

Mapping Unit 43 is similar to Mapping Unit 42 with the exception of vegetation and inclusions, and to Mapping Unit 37 with the exception of landform and inclusions.

Soil 43 is a moderately deep to very deep (5-12 feet plus), nonplastic to slightly plastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are moderately thick to very thick gravelly sandy loam or gravelly silt loams.

Bedrock is composed of moderately competent to incompetent, highly to moderately fractured pyroclastic rock.

Typically, Soil 43 occurs on slightly to moderately dissected, somewhat uneven valley bottoms, toeslopes, terraces and broad ridgetops of less than 35-percent slope. This soil ranges in elevation from 3,000 to 6,000 feet and supports Douglas-fir,white fir, western larch, ponderosa pine and true fir. This soil is well drained. Permeability is rapid in the surface soils and moderately rapid in the subsoils.

Range of Profile Characteristics of Soil 43

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark brown to brown sandy loam ranging to silty clay loam; weak, fine, subangular blocky structure; 10 to 40 percent subangular gravel by volume; nonsticky to slightly sticky; nonplastic to slightly plastic; pH ranges from 5.0 to 6.0. 12 to 36 inches thick.

Subsoil Layers - Very dark grayish brown to yellowish brown gravelly clay loam ranging to gravelly sandy loam; massive; 30 to 60 percent subangular gravel and cobbles by volume; slightly sticky to sticky, slightly plastic to plastic; pH ranges from 5.0 to 6.0. 48 to greater than 108 inches thick.

Some Important Soil Limitations and Interpretations

Soil 43 has the following important limitations and interpretations:

Recreation

1. Suitability for Recreation Area Development - This soil has low to moderate suitability. Limitations result from fine textures locally that cause muddiness and restrict drainage.

2. Suitability for Sewage Filter Field - Slopes under 10 percent vary in suitability from poor to moderate. Limitations are caused by fine textures locally in the subsoils that restrict downward drainage and cause the effluent to move laterally. This may appear at the surface or reach bodies of water causing contamination.

Timber Management

Limitations to Regeneration and Tree Growth - Few limitations are present on this soil except at the highest elevations where limitations are caused by cold climatic factors and low soil fertility. Heavy snows and cold temperatures result in short growing seasons. Cold soil temperatures occur during part of the growing season which cause limited microbiological activity, resulting in slow nutrient release. This restricts growth and affects regeneration.

Planting success is related to soil temperatures. The most favorable soil conditions generally occur some time after the spring snowmelt when soil temperatures begin warming and the moisture supply is still adequate.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods

a. Tractor - This soil has the potential to incur moderate damage from this method. Damage can result from tractor turning and blade and log gouging that may cause soil loosening, displacement, and some compaction. Compaction damage may be locally severe during wet conditions. The extent of damage that is actually caused depends upon such factors as soil wetness at the time of operation, frequency of tractor passes, and the care and skill of the tractor operator.

b. Partially Suspended Cable System - The potential impact from this method is relatively low. Some soil damage may result from log skidding and gouging.

MAPPING UNIT 44

Mapping Unit 44 consists of Soil 44 and inclusions of other soils. The most common inclusions are Soils 45 and 42.

Mapping Unit 44 is similar to Mapping Unit 45 with the exception of vegetation and inclusions.

Soil 44 is a very deep slightly plastic to plastic soil derived from residuum. Surface soils are generally thin loams. Subsoils are generally very thick silty clay or clay.

Bedrock is incompetent pyroclastic or igneous rock and occurs 12 feet or more beneath the soil surface.

Typically, Soil 44 occurs on uneven and hummocky, slightly to moderately dissected slopes of less than 35 percent. This soil ranges in elevation from 1,800 to 4,000 feet and supports ponderosa pine and Douglas-fir.

This soil is moderately well to imperfectly drained. Permeability is rapid to moderately rapid in the surface soils and slow to very slow in the subsoils.

Range of Profile Characteristics of Soil 44

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 2 inches thick.

Surface Layers - Dark reddish brown to very dark gray silty clay ranging to loam; moderate to strong, fine subangular blocky structure; 0 to 20 percent subangular gravel by volume; slightly sticky to sticky, slightly plastic to plastic; pH ranges from 5.0 to 6.0. 12 to 30 inches thick.

Subsoil Layers - Dark reddish brown to brown clay ranging to clay loam; massive; 0 to 25 percent subangular gravel by volume; sticky, plastic; pH ranges from 5.0 to 6.0. 132 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 44 has the following important limitations and interpretations:

Recreation

1. Suitability for Recreation Area Development - This soil has low suitability. Soils are fine-textured and have drainage restrictions. This results in severe muddiness tendencies during wet periods. Soils are easily compacted by trampling which causes increased erosion and decreased vegetative growth.

2. Suitability for Sewage Filter Field - This soil has poor suitability. Drainage restrictions and local high water tables cause high potential for contamination of ground water and nearby streams and ponds. There is also a high potential for the effluent to appear at the soil surface, resulting in wetness and disagreeable odors.

Watershed

Sediment Yield Potential - Whenever this soil is exposed, such as in harvest units or on road cutslopes and wasteslopes, it has a high potential to yield sediment of silt and clay to streams. This sediment may damage fish-spawning beds, cause loss to water quality and reduce the life of reservoirs.

Engineering

1. Susceptibility to Cutbank Sloughing and Raveling - This is a severe problem on this soil. Subsoil materials have a tendency to continually slough on exposed cutbanks. This requires frequent maintenance and causes potential damage to water and fishery values.

2. Probability of Cutbank Failure - This soil has the probability that from 9 to 15 failures of at least 10 cubic yards each will occur per mile. (Based on cutbank height of 10 feet.)

3. Considerations for Road Location and Construction - In addition to problems discussed in previous interpretations, all-weather roads on this soil will require relatively thick base coarse and frequent culverts. Proper compaction of fills may be difficult to obtain because of excessive moisture. Cutbank stability control may require measures such as planting willow shoots and/or the local installation of horizontal drains and binwalls.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - The potential impact is high on this soil. Damage may be caused by tractor turning and blade and log gouging that destroys protective duff, displaces soils, causes structure loss, may increase slide activity, and may cause severe soil compaction. Compacted soils restrict water infiltration, root penetration, and soil aeration. Erosion and stream sedimentation potential is greatly increased and loss of soil productivity may result.

   b. Partially Suspended Cable System - The potential impact is moderate (locally severe due to road damage). Logs which are skidded on these soils will have potential to compact soils, remove duff protection, and provide channels for water accumulation, resulting in erosion of soils and sedimentation of streams. Much of the total damage may be caused by access roads as exposed surfaces of roadcuts and fills have high potential for sloughing and raveling.

2. Engineering Practices

Roads may have a moderate (locally severe) impact on soil and water values on this soil. Roads increase the potential for slumps and slides. Cutslopes and wasteslopes slough, ravel and erode and have a high potential for failure. These soil movements may contribute sediment to streams and cause losses to water quality and fishery values.

MAPPING UNIT 45

Mapping Unit 45 consists of Soil 45 and inclusions of other soils. The most common inclusions are Soils 44 and 43.

Mapping Unit 45 is similar to Mapping Unit 44 with the exception of vegetation and inclusions.

Soil 45 is a very deep, slightly plastic to plastic soil derived from residuum. Surface soils are generally thin loams. Subsoils are generally very thick silty clays or clay.

Bedrock is incompetent pyroclastic or igneous rock and occurs 12 feet or more beneath the soil surface.

Typically, Soil 45 occurs on uneven and hummocky, slightly to moderately dissected slopes of less than 35 percent. This soil ranges in elevation from 3,000 to 6,000 feet and supports Douglas-fir, white fir, western larch, mountain hemlock and true fir. This soil is moderately well to imperfectly drained. Permeability is rapid to moderately rapid in the surface soils and slow to very slow in the subsoils.

Range of Profile Characteristics of Soil 45

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark reddish brown to very dark gray silty clay ranging to loam; moderate to strong, fine subangular block structure; 0 to 20 percent subangular gravel by volume; slightly sticky to sticky, slightly plastic to plastic; pH ranges from 5.0 to 6.0. 12 to 30 inches thick.

Subsoil Layers - Dark reddish brown to brown clay ranging to clay loam; massive; 0 to 25 percent subangular gravel by volume; sticky, plastic; pH ranges from 5.0 to 6.0. 132 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 45 has the following important limitations and interpretations:

Recreation

1. Suitability for Recreation Area Development - This soil has low suitability. Soils are fine-textured and have drainage restrictions. This results in severe muddiness tendencies during wet periods. Soils are easily compacted by trampling which causes increased erosion and decreased vegetative growth.

2. Suitability for Sewage Filter Field - This soil has poor suitability. Drainage restrictions and local high water tables cause high potential for contamination of ground water and nearby streams and ponds. There is also a high potential for the effluent to appear at the soil surface, resulting in wetness and disagreeable odors.

Watershed

Sediment Yield Potential - Whenever this soil is exposed, such as in harvest units or on road cutslopes and wasteslopes, it has a high potential to yield sediment of silt and clay to streams. This sediment may damage fish-spawning beds, cause loss to water quality and reduce the life of reservoirs.

Engineering

1. Susceptibility to Cutbank Sloughing and Raveling - This is a severe problem on this soil. Subsoil materials have a tendency to continually slough on exposed cutbanks. This requires frequent maintenance and causes potential damage to water and fishery values.

2. Probability of Cutbank Failure - This soil has the probability that from 9 to 15 failures of at least 10 cubic yards each will occur per mile. (Based on cutbank height of 10 feet.)

3. Considerations for Road Location and Construction - In addition to problems discussed in previous interpretations, all-weather roads on this soil will require relatively thick base coarse and frequent culverts. Proper compaction of fills may be difficult to obtain because of excessive moisture. Cutbank stability control may require measures such as planting willow shoots and/or the local installation of horizontal drains and binwalls.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - The potential impact is high on this soil. Damage may be caused by tractor turning and blade and log gouging that destroys protective duff, displaces soils, causes structure loss, may increase slide activity, and may cause severe soil compaction. Compacted soils restrict water infiltration, root penetration, and soil aeration. Erosion and stream sedimentation potential is greatly increased and loss of soil productivity may result.

   b. Partially Suspended Cable System - The potential impact is moderate (locally severe due to road damage). Logs which are skidded on these soils will have potential to compact soils, remove duff protection, and provide channels for water accumulation, resulting in erosion of soils and sedimentation of streams. Much of the total damage may be caused by access roads as exposed surfaces of roadcuts and fills have high potential for sloughing and raveling.

2. Engineering Practices

Roads may have a moderate (locally severe) impact on soil and water values on this soil. Roads increase the potential for slumps and slides. Cutslopes and wasteslopes slough, ravel and erode and have a high potential for failure. These soil movements may contribute sediment to streams and cause losses to water quality and fishery values.

MAPPING UNIT 46

Mapping Unit 46 consists of Soil 46 and inclusions of other soils. The most common inclusions are Soils 38 and 45.

Soil 46 is an active landflow consisting of very deep plastic to very plastic soils. Surface soils and subsoils have clay textures.

Bedrock is incompetent pyroclastic or igneous rock and occurs more than 12 feet beneath the soil surface.

Typically, Soil 46 occurs on hummocky landforms which range from 10-to 50-percent slope.

This soil ranges in elevation from 3,000 to 5,500 feet and supports ponderosa pine, Douglas-fir, mountain hemlock, white fir and western redcedar. This soil is imperfectly to poorly drained. Permeability is slow in the surface soils and very slow in the subsoils.

Range of Profile Characteristics of Soil 46

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Very dark brown to grayish brown clay ranging to silty clay; strong, fine subangular blocky structure; 0 to 15 percent subangular gravel by volume; very sticky, very plastic; pH ranges from 6.0 to 6.5. 6 to 18 inches thick.

Subsoil Layers - Reddish brown to light gray clay; massive; 0 to 25 percent subangular gravel and cobbles by volume; very sticky, very plastic; pH ranges from 5.5 to 6.5. 138 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 46 has the following important limitations and interpretations:

Watershed

1. Natural Stability - This mapping unit consists of actively moving landflows that are very unstable.

2. Expected Mass Movement as a Result of Man's Activities - The rate of failure is expected to greatly increase over the natural state as a result of road construction and timber harvest activities.

3. Sediment Yield Potential - Whenever this soil is exposed, such as in harvest units or on road cutbanks and wasteslopes, it has a very high potential to yield sediment of silt and clay to streams. Much of this sediment remains in water suspension for extended periods and may cause severe losses to water quality and fisheries.

Engineering

1. Susceptibility to Cutbank Slough and Ravel - This is a very severe problem on this soil as the exposed cutbanks continually slough, ravel and fail. This requires frequent maintenance and causes potential losses to soil and water values.

2. Probability of Cutbank Failures - This soil has the probability that over 15 failures of at least 10 cubic yards each will occur per mile. In addition, there is potential for increased slide activity throughout the landflow.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - There is potential for severe impact from this method. Tractor operation on these very unstable soils will damage soil structure, cause compaction, and is likely to greatly increase the slide activity.

   b. Partially Suspended Cable System - The potential impact from this method is high. Soil disturbance may result that increases sedimentation and causes small slides. Access roads may cause massive failures that cause severe damage to soils, water and other resources.

   c. Aerial Logging - Moderate impact damage may result from this method. Removal of trees reduces evapotranspiration, resulting in increased soil water. This reduces internal friction and cohesion that may cause an increase in slump and slide activity. Also, as tree roots decompose, their soil stabilizing effects from soil binding are reduced.

2. Engineering Practices - The soil and water impact can be very severe on this soil. Roads greatly increase the potential for slumps and slides, both small and large, that may severely damage soil, water and other resources.

MAPPING UNIT 50

Mapping Unit 50 consists of intermixed pyroclastic and extrusive igneous rock outcrop and inclusions of soils. The most common inclusions are Soils 5, 36, 37, 52, 53, 54 and 55.

The mixed pyroclastic and igneous rock outcrop is composed of tuffs, andesitic breccias, andesite and basalt. This rock ranges from hard to moderately hard, and competent to moderately competent.

This mapping unit occurs on ridgecrests and sideslopes.

MAPPING UNIT 52

Mapping Unit 52 consists of Soil 52 and inclusions of other soils. The most common inclusions are Soils 53, 54, 50, 51, 36, 61 and 62.

Mapping Unit 52 is similar to Mapping Unit 53 with the exception of vegetation and inclusions, and to Mapping Units 31, 61 and 62 with the exception of bedrock type and inclusions.

Soil 52 is a shallow to moderately deep (commonly 1-4 feet), nonplastic to slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly loams or gravelly silt loams.

Bedrock is composed of moderately competent to competent, highly fractured intermixed andesite, basalt or pyroclastic rock.

Typically, Soil 52 occurs on steep, smooth, nondissected to slightly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 1,800 to 4,000 feet and supports ponderosa pine and Douglas-fir. This soil is well drained and permeability is rapid.

Range of Profile Characteristics of Soil 52

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface Layers - Very dark grayish brown to dark yellowish brown sandy loam ranging to loam; weak, fine, subangular blocky structure; 5 to 35 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 6.0 to 6.6. 4 to 20 inches thick.

Subsoil Layers - Dark yellowish brown to strong brown gravelly silt loam ranging to gravelly loam; moderate, medium, subangular blocky structure; 30 to 55 percent subangular gravel and cobbles by volume; slightly sticky, slightly plastic to nonplastic; pH ranges from 5.5 to 6.5. 8 to 28 inches thick.

Some Important Soil Limitations and Interpretations

Soil 52 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Timber Management

1. Limitations to Regeneration and Tree Growth - Limitations that affect Douglas-fir in particular are present at the eastern portion of the area and on south-facing slopes. This includes both naturals and plantations. Hot summer soil temperatures, limited soil moisture and relatively infertile soils are primary limitations.

   These factors also cause restrictions in time of planting. The best success can be expected when soil moisture and temperature conditions are satisfactory for growth. This usually occurs near the time of spring snowmelt.

2. Planting Species - Soil and climatic factors, along with observations, indicate that ponderosa pine plantings are better adapted than Douglas-fir on the more droughty slopes, and would require less intensive management to ensure survival and growth.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally much too steep (greater than 35 percent) to be tractor operable without having the potential for causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - This method has the potential for causing low to moderate damage, depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

   Roads have a low to moderate impact potential on soil and water values with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A major impact is from excavation waste when sidecast on the steeper slopes. Sidecast material ravels and erodes and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 53

Mapping Unit 53 consists of Soil 53 and inclusions of other soils. The most common inclusions are Soils 52, 55, 50, 32, 37, 62 and 63.

Mapping Unit 53 is similar to Mapping Unit 52 with the exception of vegetation and inclusions, and to Mapping Units 32, 62 and 63, with the exception of bedrock type and inclusions.

Soil 53 is a shallow to moderately deep (commonly 1-4 feet), nonplastic to slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly loams or gravelly silt loams.

Bedrock is composed of moderately competent to competent, highly fractured intermixed andesite, basalt or pyroclastic rock.

Typically, Soil 53 occurs on steep, smooth nondissected to slightly dissected sideslopes of greater than 35 percent slope. This slope ranges in elevation from 3,000 to 7,500 feet and supports Douglas-fir, western larch, white fir, mountain hemlock and true fir. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 53

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface Layers - Very dark grayish brown to dark yellowish brown sandy loam, ranging to loam; weak, fine, subangular blocky structure; 5 to 35 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 6.0 to 6.6. 4 to 20 inches thick.

Subsoil Layers - Dark yellowish brown to strong brown gravelly silt loam ranging to gravelly loam; moderate, medium, subangular blocky structure; 30 to 55 percent subangular gravel and cobbles by volume; slightly sticky, slightly plastic to nonplastic; pH ranges from 5.5 to 6.5. 8 to 28 inches thick.

Some Important Soil Limitations and Interpretations

Soil 53 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Timber Management

1. Limitations to Regeneration and Tree Growth - Limitations that affect Douglas-fir in particular are present at the eastern portion of the area and on south-facing slopes. This includes both naturals and plantations. Hot summer soil temperatures, limited soil moisture and relatively infertile soils are primary limitations.

   These factors also cause restrictions in time of planting. The best success can be expected when soil moisture and temperature conditions are satisfactory for growth. This usually occurs near the time of spring snowmelt.

2. Planting Species - Soil and climatic factors, along with observations, indicate that ponderosa pine plantings are better adapted than Douglas-fir on the more droughty slopes, and would require less intensive management to ensure survival and growth.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally much too steep (greater than 35 percent) to be tractor operable without having the potential for causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - This method has the potential for causing low to moderate damage, depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated. under "Engineering Practices."

2. Engineering Practices

   Roads have a low to moderate impact potential on soil and water values with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A major impact is from excavation waste when sidecast on the steeper slopes. Sidecast material ravels and erodes and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 54

Mapping Unit 54 consists of Soil 54 and inclusions of other soils. The most common inclusions are Soils 50, 52 and 55.

Mapping Unit 54 is similar to Mapping Unit 55 with the exception of vegetation and inclusions, and to Mapping Unit 52 with the exception of landform and inclusions.

Soil 54 is a shallow (commonly 1-3 feet), nonplastic to slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly loams or gravelly silt loams.

Bedrock is composed of moderately competent to competent, highly fractured intermixed andesite, basalt or pyroclastic rock.

Typically, Soil 54 occurs on very steep, highly dissected ridge systems having greater than 35-percent slope. This soil ranges in elevation from 1,800 to 4,000 feet and supports ponderosa pine and Douglas-fir. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 54

Litter	-	Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.
Surface Layers	-	Very dark grayish brown to dark yellowish brown sandy loam, ranging to loam; weak, fine, subangular blocky structure; 5 to 35 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 6.0 to 6.6. 6 to 15 inches thick.
Subsoil Layers	-	Dark yellowish brown to strong brown gravelly silt loam ranging to gravelly loam; moderate, medium, subangular blocky structure; 30 to 55 percent subangular gravel and cobbles by volume; slightly sticky, slightly plastic to nonplastic; pH ranges from 5.5 to 6.5. 6 to 21 inches thick.

Some Important Soil Limitations and Interpretations

Soil 54 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed (see "Common Soil Problems"). A factor that greatly increases the erosion potential locally is the presence of rock outcrops on barren rock slopes located upslope of soils. Rainwater or snowmelt rapidly runs off these slopes and flows onto downslope soils at high velocity. This can cause very severe erosion unless the soils have protective vegetative cover.

Timber Management

1. Limitations to Regeneration and Tree Growth - Limitations that affect Douglas-fir in particular are present at the eastern portion of the area and on south-facing slopes. This includes both naturals and plantations. Hot summer soil temperatures, limited soil moisture and relatively infertile soils are primary limitations.

   These factors also cause restrictions in time of planting. The best success can be expected when soil moisture and temperature conditions are satisfactory for growth. This usually occurs near the time of spring snowmelt.

2. Planting Species - Soil and climatic factors, along with observations, indicate that ponderosa pine plantings are better adapted than Douglas-fir on the more droughty slopes, and would require less intensive management to ensure survival and growth.

Engineering

1. Failure and Erosion on Road Waste and Fills - is a moderate to severe problem. The steep dissected nature of the topography along with loose soil materials allows for considerable raveling and sloughing.

2. Considerations for Road Location and Construction - The steep and dissected topography requires considerable excavation and results in poor road alignment

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is too steep (greater than 35 percent) to be tractor operable without the potential for causing excessive soil damage (see "Common Soil Problems.)"

   b. Partially Suspended Cable System - This method has the potential for causing moderate to severe damage, depending upon such factors as steepness of slope, frequency of dissections and the design and frequency of access roads. The steep, dissected topography often permits logs to become temporarily airborne prior to slamming into and gouging the soils. This may cause soil displacement that allows soils to be vulnerable to erosion damage. Much of the total damage may be related to the access roads. Roads may cause considerable soil exposure on cutslopes and wasteslopes that are subject to erosion and sloughing. This causes soil loss and when occurring near streams, it has potential for damage to water quality and fisheries.

   c. Fully Suspended Cable System - This method can be expected to cause little or no soil damage from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as previously indicated.

2. Engineering Practices

   Roads have a moderate to severe impact potential on soil and water values with the greatest potential occurring at or near streams and on slopes over 60 percent. A major impact is from excavation waste when sidecast. Sidecast material often ravels and sloughs and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 55

Mapping Unit 55 consists of Soil 55 and inclusions of other soils. The most common inclusions are Soils 54, 53, 50 and 37.

Mapping Unit 55 is similar to Mapping Unit 54 with the exception of vegetation and inclusions, and to Mapping Unit 53 with the exception of landform and inclusions.

Soil 55 is a shallow (commonly 1-3 feet), nonplastic to slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly loams or gravelly silt loams.

Bedrock is composed of moderately competent to competent, highly fractured, intermixed andesite, basalt or pyroclastic rock.

Typically, Soil 55 occurs on very steep, highly dissected ridge systems having greater than 35-percent slope. This soil ranges in elevation from 3,000 to 7,500 feet and supports Douglas-fir, white fir, western larch, mountain hemlock and true fir. This soil is well drained. Permeability is rapid..

Range of Profile Characteristics of Soil 55

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface Layers - Very dark grayish brown to dark yellowish brown sandy loam ranging to loam; weak, fine, subangular blocky structure; 5 to 35 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 6.0 to 6.6. 6 to 12 inches thick.

Subsoil Layers - Dark yellowish brown to strong brown gravelly silt loam, ranging to gravelly loam; moderate, medium, subangular blocky structure; 30 to 55 percent subangular gravel and cobbles by volume; slightly sticky, slightly plastic to nonplastic; pH ranges from 5.5 to 6.5. 6 to 24 inches thick.

Some Important Soil Limitations and Interpretations

Soil 55 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.") A factor that greatly increases the erosion potential locally is the presence of rock outcrops or barren rock slopes located upslope of soils. Rainwater or snowmelt rapidly runs off these slopes and flows onto downslope soils at high velocity. This can cause very severe erosion unless the soils have protective vegetative cover.

Timber Management

Limitations to Regeneration and Tree Growth - Limitations that affect Douglas-fir in particular are present at the higher elevations due primarily to cold soils and short growing seasons. Soils are cold for extended periods and, therefore, have less microbiological activity which is necessary for plant growth.

Engineering

1. Failure and Erosion on Road Waste and Fills - is a moderate to severe problem. The steep dissected nature of the topography along with loose soil materials allows for considerable raveling and sloughing.

2. Considerations for Road Location and Construction - The steep and dissected topography requires considerable excavation and results in poor road alignment.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is too steep (greater than 35 percent) to be tractor operable without the potential for causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - This method has the potential for causing moderate to severe damage, depending upon such factors as steepness of slope, frequency of dissections and the design and frequency of access roads. The steep, dissected topography often permits logs to become temporarily airborne prior to slamming into and gouging the soils. This may cause soil displacement that allows soils to be vulnerable to erosion damage. Much of the total damage may be related to the access roads. Roads may cause considerable soil exposure on cutslopes and wasteslopes that are subject to erosion and sloughing. This causes soil loss and when occurring near streams, it has potential for damage to water quality and fisheries.

   c. Fully Suspended Cable System - This method can be expected to cause little or no soil damage from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as previously indicated.

2. Engineering Practices - Roads have a moderate to severe impact potential on soil and water values with the greatest potential occurring at or near streams and on slopes over 60 percent. A major impact is from excavation waste when sidecast. Sidecast material often ravels and sloughs, and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 60

Mapping Unit 60 consists of andesite and basalt rock outcrop and inclusion of soils. The most common inclusions are Soils 5, 61, 62 and 63.

Bedrock is generally competent and highly fractured.

This mapping unit occurs on ridgecrests and steep sideslopes.

MAPPING UNIT 61

Mapping Unit 61 consists of Soil 61 and inclusions of other soils. The most common inclusions are Soils 62, 64 and 60.

Mapping Unit 61 is similar to Mapping Units 62 and 63 with the exception of vegetation and inclusions.

Soil 61 is a shallow to moderately deep (commonly 1-4 feet), nonplastic soil derived from residuum. Surface soils are generally thin loams. Subsoils are generally thin gravelly loams or gravelly silt loams.

Bedrock is composed of competent, highly fractured andesite or basalt rock.

Typically, Soil 61 occurs on steep, smooth sideslopes of greater than 35-percent slope. This soil ranges in elevation from 1,800 to 4,500 feet and supports grasses, forbs and brush with some areas supporting scattered ponderosa pine. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 61

Litter - Needles, leaves, twigs and decomposing organic matter. 0 to 0.5 inch thick.

Surface Layers - Brown to very dark brown loam or gravelly loam ranging to gravelly sandy loam; weak to moderate, fine subangular blocky structure; 15 to 50 percent subangular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 5.0 to 6.5. 3 to 20 inches thick.

Subsoil Layers - Dark brown to dark yellowish brown gravelly loam ranging to gravelly silt loam; massive; 30 to 50 percent subangular gravel and cobbles by volume; slightly sticky, nonplastic to slightly plastic; pH ranges from 5.0 to 6.0. 9 to 28 inches thick.

Some Important Soil Limitations and Interpretations

Soil 61 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Timber Management

Limitations to Tree Growth - This soil normally supports grasses, forbs, and brush with some areas supporting very scattered ponderosa pine. This soil will not support significant timber stands because of severe soil and climatic limitations. These limitations are caused by low annual precipitation, hot summer soil temperatures and low soil moisture-holding capacity.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   This section was not evaluated due to the sparsity of timber.

2. Engineering Practices

   Roads have a low to moderate impact potential on soil and water values with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A major impact is from excavation waste when sidecast on the steeper slopes. Sidecast material ravels and erodes and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 62

Mapping Unit 62 consists of Soil 62 and inclusions of other soils. The most common inclusions are Soils 61, 63, 65, 66 and 60.

Mapping Unit 62 is similar to Mapping Units 61 and 63 with the exception of vegetation and inclusions, and to Mapping Units 65 and 66 with the exception of landform and inclusions.

Soil 62 is a shallow to moderately deep (commonly 1-4 feet), slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin loams. Subsoils are generally thin gravelly loams or gravelly silt loams.

Bedrock is composed of competent, highly fractured andesite or basalt rock.

Typically, Soil 62 occurs on steep, smooth sideslopes of greater than 35-percent slope. This soil ranges in elevation from 1,800 to 5,000 feet and

supports ponderosa pine, Douglas-fir, western larch and true fir. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 62

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Brown to very dark brown loam or gravelly loam; weak to moderate, fine subangular blocky structure; 15 to 50 percent subangular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 5.0 to 6.5. 5 to 20 inches thick.

Subsoil Layers - Dark brown to dark yellowish brown gravelly loam ranging to gravelly silt loam; massive; 30 to 50 percent subangular gravel and cobbles by volume; slightly sticky, nonplastic to slightly plastic; pH ranges from 5.0 to 6.0. 7 to 28 inches thick.

Some Important Soil Limitations and Interpretations

Soil 62 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Selected Soil and Watershed Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally much too steep (greater than 35 percent) to be tractor operable without having the potential for causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - This method has the potential for causing low to moderate damage, depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

   Roads have a low to moderate impact potential on soil and water values with the greatest impact potential occurring at or near streams and on

slopes over 60 percent. A major impact is from excavation waste when sidecast on the steeper slopes. Sidecast material ravels and erodes and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 63

Mapping Unit 63 consists of Soil 63 and inclusions of other soils. The most common inclusions are Soils 62, 67 and 60.

Mapping Unit 63 is similar to Mapping Units 61 and 62 with the exception of vegetation and inclusions, and to Mapping Unit 67 with the exception of landform and inclusions.

Soil 63 is a shallow to moderately deep (commonly 1-4 feet), slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin loams. Subsoils are generally thin gravelly loams or gravelly silt loams.

Bedrock is composed of competent, highly fractured andesite or basalt rock.

Typically, Soil 63 occurs on steep, smooth sideslopes of greater than 35-percent slope. This soil ranges in elevation from 4,500 to 7,500 feet and supports alpine fir, true fir, Engelmann spruce, mountain hemlock and western white pine. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 63

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Brown to very dark brown loam or gravelly loam ranging to gravelly sandy loam; weak to moderate; fine, subangular blocky structure; 15 to 50 percent subangular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 5.0 to 6.5. 6 to 20 inches thick.

Subsoil Layers - Dark brown to dark yellowish brown gravelly loam ranging to gravelly silt loam; massive; 30 to 50 percent subangular gravel and cobbles by volume; slightly sticky, nonplastic to slightly plastic; pH ranges from 5.0 to 6.0. 6 to 28 inches thick.

Some Important Soil Limitations and Interpretations

Soil 63 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Timber Management

Limitations to Regeneration and Tree Growth - Limitations that affect Douglas-fir in particular are present at the higher elevations due primarily to cold soils and short growing season. Soils are cold for extended periods and, therefore, have less microbiological activity which is necessary for plant growth.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally much too steep (greater than 35 percent) to be tractor operable without having the potential for causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - This method has the potential for causing low to moderate damage, depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

   Roads have a low to moderate impact potential on soil and water values with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A major impact is from excavation waste when sidecast on the steeper slopes. Sidecast material ravels and erodes and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 64

Mapping Unit 64 consists of Soil 64 and inclusions of other soils. The most common inclusions are Soils 65 and 61.

Soil 64 is a very shallow (less than 12 inches), slightly plastic soil derived from residuum. Soils are generally loams or silt loams.

Bedrock is composed of competent, highly fractured andesite or basalt rock.

Typically, Soil 64 occurs on flat tablelands with slopes less than 35 percent. This soil ranges in elevation from 2,000 to 5,000 feet and supports grasses, forbs and brush. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 64

Litter - Leaves, twigs and decomposing organic matter. 0 to 0.5 inches thick.

Surface Layers - Dark brown to brown loam ranging to silt loam; massive; 10 to 25 percent subangular gravel and cobbles by volume; slightly sticky, slightly plastic; pH ranges from 5.0 to 6.0. 1 to 6 inches thick.

Subsoil Layers - Dark brown to light brown silt loam ranging to loam; massive; 10 to 25 percent subangular gravel and cobbles by volume; slightly sticky, slightly plastic; pH ranges from 5.0 to 6.0. 4 to 8 inches thick.

Some Important Soil Limitations and Interpretations

Soil 64 has the following important limitations and interpretations:

Recreation

Suitability for Recreation Area Development

This soil has low suitability. Soils and vegetation are fragile and easily destroyed by trampling. The very shallow soil depth severely restricts filter field use.

Range

1. Susceptibility to Damage by Livestock - The trampling by livestock easily damages the fragile soils and vegetation.

2. Potential for Range Improvement through Seeding - The potential for improvement on this soil is very low. This is because the extreme shallowness of the soil causes very low moisture-holding capacity. The soil is droughty during much of the year and is very limited in its ability to support growth.

MAPPING UNIT 65

Mapping Unit 65 consists of Soil 65 and inclusions of other soils. The most common inclusions are Soils 64, 66 and 62.

Mapping Unit 65 is similar to Mapping Unit 62 with the exception of landform and inclusions, and to Mapping Units 66 and 67 with the exception of vegetation and inclusions.

Soil 65 is a shallow to moderately deep (commonly 2-5 feet), nonplastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly loams.

Bedrock is composed of competent, highly fractured andesite or basalt rock.

Typically, Soil 65 occurs on smooth to somewhat uneven ridgetops or terraces of less than 35-percent slope. This soil ranges in elevation from 1,800 to 5,000 feet and supports ponderosa pine and Douglas-fir. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 65

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface Layers - Dark brown to brown sandy loam ranging to loam; weak, fine, subangular blocky structure; 10 to 35 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 5.5 to 6.0. 6 to 20 inches thick.

Subsoil Layers - Dark brown to brown silt loam ranging to sandy loam; massive; 15 to 40 percent subangular gravel and cobbles by volume; slightly sticky to nonsticky, nonplastic; pH ranges from 5.5 to 6.5. 18 to 40 inches thick.

Some Important Soil Limitations and Interpretations

Soil 65 has the following important limitations and interpretations:

Recreation

Suitability for Recreation Area Development - This soil has moderate suitability. Limitations are caused by shallow soil depth which restricts filter field use.

Timber Management

Limitations to Regeneration and Tree Growth - Limitations are caused by low precipitation, hot summer soil temperatures and limited soil moisture-holding capacity. These limitations are the most expressed along the eastern edge of the area.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - The potential impact is relatively low. Some soil damage can result from tractor turning and blade and log gouging that may cause soil loosening and displacement. The amount of damage depends to a large extent upon the care and skill of the tractor operator.

b. Partially Suspended Cable System - Only minimal soil damage would be expected with this system.

MAPPING UNIT 66

Mapping Unit 66 consists of Soil 66 and inclusions of other soils. The most common inclusions are Soils 65, 67 and 62.

Mapping Unit 66 is similar to Mapping Unit 62 with the exception of landform and inclusions, and to Mapping Unit 67 with the exception of vegetation and inclusions.

Soil 66 is a shallow to moderately deep (commonly 2-5 feet), nonplastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly loams.

Bedrock is composed of competent, highly-fractured andesite or basalt rock.

Typically, Soil 66 occurs on smooth to somewhat uneven ridgetops and terraces of less than 35-percent slope. This soil ranges in elevation from 3,500 to 6,500 feet and supports Douglas-fir, white fir, western larch and true fir. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 66

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark brown to brown sandy loam, ranging to loam; weak, fine, subangular blocky structure; 10 to 35-percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic; pH ranges from 5.5 to 6.0. 6 to 18 inches thick.

Subsoil Layers - Dark brown to reddish brown silt loam, ranging to sandy loam; massive; 15 to 40 percent subangular gravel and cobbles by volume; slightly sticky to nonsticky, nonplastic; pH ranges from 5.5 to 6.5. 18 to 42 inches thick.

Some Important Soil Limitations and Interpretations

Soil 66 has the following important limitations and interpretations:

Recreation

Suitability for Recreation Area Development - This soil has moderate suitability. Limitations are caused by shallow soil depth which restricts filter field use.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods

a. Tractor - The potential impact is relatively low. Some soil damage can result from tractor turning and blade and log gouging that may cause soil loosening and displacement. The amount of damage depends to a large extent upon the care and skill of the tractor operator.

b. Partially Suspended Cable System - Only minimal soil damage would be expected with this system.

MAPPING UNIT 67

Mapping Unit 67 consists of Soil 67 and inclusions of other soils. The most common inclusions are Soils 66 and 63.

Mapping Unit 67 is similar to Mapping Unit 63 with the exception of landform and inclusions, and to Mapping Unit 66 with the exception of vegetation and inclusions.

Soil 67 is a shallow to moderately deep (commonly 1-4 feet), nonplastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are generally thin gravelly loams or gravelly sandy loams.

Bedrock is composed of competent, highly fractured andesite or basalt rock.

Typically, Soil 67 occurs on smooth to somewhat uneven ridgetops and terraces of less than 35-percent slope. This soil ranges in elevation from 5,000 to 7,500 feet and supports alpine fir, true fir, Engelmann spruce, mountain hemlock and western white pine. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 67

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark brown to brown sandy loam ranging to loam; single-grained; 10 to 30 percent subangular gravel by volume; nonsticky, nonplastic; pH ranges from 4.5 to 5.5. 6 to 18 inches thick.

Subsoil Layers - Dark brown to reddish brown gravelly loam or loam, ranging to gravelly sandy loam or loam; massive; 15 to 40 percent subangular gravel by volume; nonsticky, nonplastic; pH ranges from 4.5 to 5.5. 6 to 30 inches thick.

Some Important Soil Limitations and Interpretations

Soil 67 has the following important limitations and interpretations:

Recreation

Suitability for Recreation Area Development - This soil has moderate suitability. Limitations are caused by shallow soil depth which restricts filter field use.

Timber Management

1. Limitations to Regeneration and Tree Growth - Limitations are present that adversely affect regeneration and tree growth, especially Douglas-fir. This soil occurs at higher elevations that have limitations of short growing season, cold soils, and frost heave. Cold soil temperatures occur during part of the growing season, which causes slow microbiological activity resulting in slow nutrient release. This limits growth and affects regeneration.

   Planting success is related to soil temperatures. The most favorable soil conditions generally occur some time after the spring snowmelt when soil temperatures begin warming and the soil moisture supply is still adequate.

2. Planting Species - Soil and climatic factors, along with observations, indicate that true fir or larch plantings are better adapted than Douglas-fir and would require less intensive management to ensure survival and growth.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods

a. Tractor - The potential impact is relatively low. Some soil damage can result from tractor turning and blade and log gouging that may cause soil loosening and displacement. The amount of damage depends to a large extent upon the care and skill of the tractor operator.

b. Partially Suspended Cable System - Only minimal soil damage would be expected with this system.

MAPPING UNIT 70

Mapping Unit 70 consists of nonmarine sedimentary rock outcrop and inclusions of soils. The most common inclusions are Soils 5, 71 and 72.

The sedimentary rock outcrop is composed of bedded sandstone, siltstone and mudstone. This rock ranges from moderately hard to soft and moderately competent to incompetent.

This mapping unit occurs on ridgecrests and sideslopes.

MAPPING UNIT 71

Mapping Unit 71 consists of Soil 71 and inclusions of other soils. The most common inclusions are Soils 72, 70 and 75.

Mapping Unit 71 is similar to Mapping Unit 72 with the exception of landform and inclusions.

Soil 71 is a shallow (commonly 1-3 feet), slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin sandy loams. Subsoils are generally thin loams or silty clay loams.

Bedrock is composed of moderately competent, highly fractured, interbedded sediments of sandstone, siltstone and mudstone.

Typically, Soil 71 occurs on steep, smooth, slightly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 5,000 feet and supports Douglas-fir, true fir, western larch and ponderosa pine. This soil is well drained. Permeability is rapid in the surface soils and rapid to moderately rapid in the subsoils.

Range of Profile Characteristics of Soil 71

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface-Layers - Dark brown to brown loam, ranging to sandy loam; weak, fine, subangular blocky structure; 5 to 30 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 5.5 to 7.0. 6 to 18 inches thick.

Subsoil-Layers - Dark brown to brown loam, ranging to silty clay loam; massive; 5 to 35 percent subangular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 5.5 to 6.5. 6 to 18 inches thick.

Some Important Soil Limitations and Interpretations

Soil 71 has the following important limitations and interpretations:

Watershed

1. Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

2. Sediment Yield Potential - Whenever this soil is exposed, such as in harvest units or on road cutbanks and wasteslopes, it has a high potential to yield sediment of sand and silt to streams. This sediment may damage fish-spawning beds and may cause loss of water quality.

Engineering

Failure and Erosion on Road Waste and Fills - This can be a problem on this soil. The steep topography, along with bedrock types that rapidly weather upon exposure, allows for considerable raveling and sloughing. When this occurs near streams it provides sediment that may be damaging to the water resource.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally much too steep (greater than 35 percent) to be tractor operable without having the potential for causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - This method has the potential of causing low to moderate damage, depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

   Roads have a low to moderate impact potential on soil and water values with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A major impact is from excavation waste when sidecast on the steeper slopes. Sidecast material ravels and erodes and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 72

Mapping Unit 72 consists of Soul 72 and inclusions of other soils. The most common inclusions are Soils 71, 70 and 75.

Mapping Unit 72 is similar to Mapping Unit 71 with the exception of landform and inclusions.

Soil 72 is a shallow to moderately deep (commonly 1-4 feet), slightly plastic soil derived from residuum and colluvium. Surface soils are generally thin sandy loams. Subsoils are generally thin loams or silty clay loams.

Bedrock is composed of moderately competent to incompetent, highly-fractured interbedded sediments of sandstone, siltstone and mudstone rock.

Typically, Soil 72 occurs on steep, highly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 5,000 feet and supports Douglas-fir, true fir, western larch and ponderosa pine. This soil is well drained. Permeability is rapid in the surface soils and rapid to moderately rapid in the subsoils.

Range of Profile Characteristics of Soil 72

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark brown to brown loam ranging to sandy loam; weak, fine, subangular blocky structure; 5 to 30 percent subangular gravel by volume; nonsticky to slightly sticky; nonplastic to slightly plastic; pH ranges from 5.5 to 7.0. 6 to 18 inches thick.

Subsoil Layers - Dark brown to brown loam ranging to silty clay loam; massive; 5 to 35 percent subangular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 5.5 to 6.5. 6 to 30 inches thick.

Some Important Soil limitations and Interpretations

Soil 72 has the following important limitations and interpretations:

Watershed

1. Natural Stability - This soil is moderately stable to unstable in its natural state.

2. Surface Erosion - This soil has the potential for very severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

3. Sediment Yield Potential - Whenever this soil is exposed, such as in harvest units or on road cutbanks and wasteslopes, it has a high potential to yield sediment of silt and clay to streams. This sediment often remains in water suspension for extended periods and may cause losses to water quality and fisheries.

Engineering

1. Susceptibility to Cutbank Slough and Ravel - This is a problem on this soil as the exposed cutbanks continually slough and ravel. This requires frequent maintenance and causes potential losses to soil and water values.

2. Failure and Erosion on Road Waste and Fills - This is a problem on this soil. When this occurs near streams, it provides sediment that may be damaging to the water resource.

3. Considerations for Road Location and Construction - The steep and dissected topography requires considerable excavation and causes poor road alignment. There is potential for damage to the soil and water resources for road-caused slides.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is too steep (greater than 35 percent) to be tractor operable without the potential for causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - This method has the potential of causing moderate to severe soil damage, depending upon such factors as steepness of slope, frequency of dissections, and the design and frequency of access roads. The steep dissected topography often permits logs to become temporarily airborne prior to slamming into and gouging the soils. This may cause soil displacement and impaction that allows soils to be vulnerable to erosion damage and may also cause small slides. Much of the total damage may be related to the access roads. Roads may cause considerable soil exposure on cutslopes and wasteslopes that are subject to erosion, sloughing and failures. This causes soil loss and when occurring near streams, it is potentially damaging to water quality and fisheries.

   c. Fully Suspended Cable System - This method can be expected to cause minimal soil damage from the actual harvest operation. However, damage may be caused by access roads and would involve the same considerations as previously indicated.

2. Engineering Practices

   The potential impact from roads is moderate to high on this soil. Roads increase the potential for slides. Cutbanks and wasteslopes slough, erode and fail. Excavation waste when sidecast causes a high impact because, in addition to sloughing and raveling, it can cause overloading of the wasteslope, resulting in wasteslope failures. This damages soils and causes potential damage to streams with loss of water quality and fisheries.

MAPPING UNIT 75

Mapping Unit 75 consists of Soil 75 and inclusions of other soils. The most common inclusions are Soils 72 and 71.

Mapping Unit 75 is similar to Mapping Unit 38 with the exception of different bedrock and inclusions.

Soil 75 is a deep to very deep (commonly 8-12 feet plus), slightly plastic to plastic soil derived from residuum and colluvium. Surface soils are generally thin sandy loams or loams. Subsoils are generally thick gravelly silty clay loams.

Bedrock is composed of incompetent, highly weathered siltstone or mudstone.

Typically, Soil 75 occurs on steep, uneven and moderately to highly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 4,500 feet and supports Douglas-fir, white fir, true fir, mountain hemlock, western redcedar, and western larch. This soil is moderately well to imperfectly drained. Permeability is rapid in the surface soils and moderately rapid to slow in the subsoils.

Range of Profile Characteristics of Soil 75

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark brown to reddish brown sandy loam, ranging to silty clay loam; moderate, fine, subangular blocky structure; 10 to 40 percent subangular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 4.5 to 5.5. 12 to 24 inches thick.

Subsoil Layers - Brown to pale brown gravelly silty clay ranging to gravelly silty clay loam; massive; 35 to 50 percent angular gravel and cobbles by volume; sticky, slightly plastic to plastic; pH ranges from 5.5 to 6.5. 84 inches thick or greater.

Some Important Soil Limitations and Interpretations

Soil 75 has the following important limitations and interpretations:

Watershed

1. Natural Stability - This soil is unstable in the natural state. The topography shows extensive evidence of past and present failures.

2. Expected Mass Movement as a Result of Man's Activities - The rate of failure is expected to greatly increase over the natural state as a result of road construction and timber harvest activities.

3. Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

4. Sediment Yield Potential - Whenever this soil is exposed, such as in harvest units or on road cutbanks and wasteslopes, it has a high potential to yield sediment of silt and clay to streams. This sediment often remains in water suspension for extended periods and may cause losses to water quality and fisheries.

Engineering

1. Susceptibility to Cutbank Slough and Ravel - This is a severe problem on this soil as the exposed cutbanks continually slough and ravel. This requires frequent maintenance and causes potential losses to soil and water values.

2. Probability of Cutbank Failures - This soil has the probability that 9 to 15 failures of at least 10 cubic yards each will occur per mile. In addition, there is the probability of an occasional failure occurring of 50 cubic yards or more.

3. Failure and Erosion on Road Waste and Fills - This is a severe problem on this soil. When this occurs near streams, it provides sediment that may be damaging to the water resource.

4. Considerations for Road Location and Construction - In addition to problems discussed in previous interpretations, all-weather roads on this soil will require relatively thick base coarse and frequent culverts. Proper compaction of fills may be difficult to obtain because of excessive moisture. Cutbank stability control may require measures such as planting willow shoots and/or local installation of horizontal drains and binwalls.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit has very severe soil and slope limitations to be tractor operable without the potential of causing extensive soil damage. Soil damage from tractor logging may result in surface soil loosening, displacement, increased slide activity and severe compaction that restricts water infiltration, root penetration and soil aeration. Also, there is greatly increased susceptibility for severe surface erosion by exposing bare soils and producing areas for water accumulation and runoff.

   b. Partially Suspended Cable System - This method has the potential to cause severe soil damage. Damage may be caused by logs becoming temporarily airborne prior to slamming into and gouging the soils. This may trigger surface slides and cause soil displacement and compaction that allows soils to be vulnerable to erosion damage. Much of the total damage is related to access roads, depending upon their design, location and frequency. Roads have a high impact potential as cutbanks and fillslopes slough, ravel and fail. Roads also increase the potential for an occasional massive failure.

   c. Fully Suspended Cable System - This method may cause moderate soil damage. Although little soil disturbance would be expected from the actual harvest operation, removal of trees may cause changes that may increase future slide activity. Removal of trees reduces evapotranspiration, resulting in increased soil water. This reduces internal friction and cohesion which may cause an increase in slump and slide activity. Also, as tree roots decompose, their soil-stabilizing effects from soil binding are lost. Considerable soil damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

The soil and water impact from roads can be very severe on this soil. Roads greatly increase the potential for slumps and slides. Cutbanks and wasteslopes slough, ravel, erode and fail, and there is potential for an occasional massive failure. Excavation waste when sidecast causes a severe impact because in addition to sloughing and raveling, it can cause overloading of the wasteslope, resulting in large wasteslope failures. This damages soils and causes potential damage to streams with loss of water quality and fisheries.

MAPPING UNIT 76

Mapping Unit 76 consists of Soil 76 and inclusions of other soils. The most common inclusions are Soils 71 and 43.

Mapping Unit 76 is similar to Mapping Unit 71 with the exception of landform and inclusions.

Soil 76 is a shallow to moderately deep (commonly 2-5 feet), slightly plastic soil derived from residuum. Surface soils are generally thin sandy loams. Subsoils are generally thin loams.

Bedrock is composed of moderately competent, highly fractured interbedded sediments of sandstone, siltstone and mudstone rock.

Typically, Soil 76 occurs on slightly uneven slopes of less than 35-percent. This soil ranges in elevation from 3,000 to 4,000 feet and supports Douglas-fir, true fir, western larch and ponderosa pine. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 76

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark brown to brown loam, ranging to sandy loam; weak, fine, subangular blocky structure; 5 to 30 percent subangular gravel by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 5.5 to 7.0. 6 to 18 inches thick.

Subsoil Layers - Dark brown to brown loam ranging to silty clay loam; massive; 5 to 35 percent subangular gravel and cobbles by volume; nonsticky to slightly sticky, nonplastic to slightly plastic; pH ranges from 5.5 to 6.5. 18 to 42 inches thick.

Some Important Soil Limitations and Interpretations

Soil 76 has the following important limitations and interpretations:

Recreation

1. Suitability for Recreation Area Development - This soil has relatively low suitability for this purpose. Limitations are caused by local wetness, high compaction hazard, and a tendency to become muddy.

2. Suitability for Filter Field - This soil has severe limitations because of shallowness.

Selected Soil and Water Impacts from Certain Management Practices

Timber Harvest Methods -

a. Tractor - There is potential for moderate damage from tractor logging especially if soils are wet. Tractor turning, blading and log gouging may destroy protective duff cover, loosen and displace soil, destroy soil structure and may cause soil compaction. The potential for erosion and stream sedimentation is increased and a loss of productivity may result. Compaction may be locally severe during wet conditions. Compacted soils adversely affect growth by restricting water infiltration, root penetration and soil aeration.

b. Partially Suspended Cable System - Only minimal soil damage would be expected with this system.

MAPPING UNIT 80

Mapping Unit 80 consists of sedimentary and metasedimentary rock outcrop and inclusions of soils. The most common inclusions are Soils 5, 6, 7, 8, 81, 82 and 83.

The bedrock is composed of argillite, graywacke, shale and siltstone. This rock ranges from hard to moderately hard and competent to moderately competent.

This mapping unit occurs on ridgecrests and sideslopes.

MAPPING UNIT 81

Mapping Unit 81 consists of Soil 81 and inclusions of other soils. The most common inclusions are Soils 13, 27 and 80.

Mapping Unit 81 is similar to Mapping Unit 82 with the exception of vegetation and inclusions.

Soil 81 is a shallow to moderately deep (commonly 2-5 feet), nonplastic soil derived from residuum and colluvium. Surface soils are generally thin gravelly sandy loams. Subsoils are generally thin gravelly sandy loams.

Bedrock is composed of moderately competent to competent, moderately to highly fractured argillite, shale, graywacke and siltstone rock.

Typically, Soil 81 occurs on steep, smooth, slightly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 4,000 feet and supports ponderosa pine and Douglas-fir. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 81

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark brown to dark grayish brown gravelly sandy loam ranging to gravelly loamy sand; single-grained; 25 to 50 percent angular and subangular gravel and cobbles by volume; nonsticky, nonplastic; pH ranges from 5.5 to 6.0. 12 to 24 inches thick.

Subsoil Layers - Dark brown to dark yellowish brown gravelly sandy loam ranging to gravelly loamy sand; single-grained; 35 to 60 percent angular gravel and cobbles by volume; nonsticky, nonplastic; pH ranges from 5.5 to 6.0. 12 to 36 inches thick.

Some Important Soil Limitations and Interpretations

Soil 81 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Engineering

Erosion of Road Waste and Fills - Road waste and fills have a high potential for erosion.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

a. Tractor - This mapping unit is generally too steep (greater than 35 percent) to be tractor operable without the risk of causing excessive soil damage. (See "Common Soil Problems.")

b. Partially Suspended Cable System - The potential for soil damage is low to moderate, depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

Roads have a low to moderate potential impact on soil and water values, with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion often occurs which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 82

Mapping Unit 82 consists of Soil 82 and inclusions of other soils. The most common inclusions are Soils 80, 83 and 27.

Mapping Unit 82 is similar to Mapping Unit 83 with the exception of landform and inclusions and Mapping Unit 81 with the exception of vegetation and inclusions.

Soil 82 is a shallow to moderately deep (commonly 2-5 feet), nonplastic soil derived from residuum and colluvium. Surface soils are generally thin gravelly sandy loams. Subsoils are generally thin gravelly sandy loams.

Bedrock is composed of moderately competent to competent, moderately to highly fractured argillite, shale, graywacke and siltstone rock.

Typically, Soil 82 occurs on steep, smooth, slightly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 6,000 feet and supports Douglas-fir, white fir, true fir, mountain hemlock and ponderosa pine. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 82

Litter	Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.
Surface Layers	Dark brown to dark grayish brown gravelly sandy loam ranging to gravelly loamy sand; single-grained; 25 to 50 percent angular and subangular gravel and cobbles by volume; nonsticky, nonplastic; pH ranges from 5.5 to 6.0. 12 to 24 inches thick.
Subsoil Layers	Dark brown to dark yellowish brown gravelly sandy loam, ranging to gravelly loamy sand; single-grained; 35 to 60 percent angular gravel and cobbles by volume; nonsticky, nonplastic; pH ranges from 5.5 to 6.0. 12 to 36 inches thick.

Some Important Soil Limitations and Interpretations

Soil 82 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Engineering

Erosion of Road Waste and Fills - Road Waste and fills have a high potential for erosion.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

a. Tractor - This mapping unit is generally too steep (greater than 35 percent) to be tractor operable without the risk of causing excessive soil damage. (See "Common Soil Problems.")

b. Partially Suspended Cable System - The potential for soil damage is low to moderate, depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

Roads have a low to moderate potential impact on soil and water values, with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches stream may be damaging to water quality and fisheries.

MAPPING UNIT 83

Mapping Unit 83 consists of Soil 83 and inclusions of other soils. The most common inclusions are Soils 80, 9 and 82.

Mapping Unit 83 is similar to Mapping Unit 82 with the exception of landform and inclusions.

Soil 83 is a shallow to moderately deep (commonly 2-5 feet), nonplastic soil derived from colluvium and residuum. Surface soils are generally thin gravelly sandy loams. Subsoils are generally thin gravelly sandy loams.

Bedrock is composed of moderately competent to competent, moderately to highly fractured argillite, shale, graywacke and siltstone rocks.

Typically, Soil 83 occurs on very steep, highly dissected sideslopes and drainages of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 6,000 feet and supports Douglas-fir, true fir, white fir and ponderosa pine. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 83

Litter - Needles, leaves, twigs and decomposing organic matter. 1 to 2 inches thick.

Surface Layers - Dark brown to dark grayish brown gravelly sandy loam, ranging to gravelly loamy sand; single-grained; 25 to 50 percent angular and subangular gravel and cobbles by volume; nonsticky, nonplastic; pH ranges from 5.5 to 6.0. 12 to 24 inches thick.

Subsoil Layers - Dark brown to dark yellowish brown gravelly sandy loam ranging to gravelly loamy sand; single-grained; 35 to 60 percent angular gravel and cobbles by volume; nonsticky, nonplastic; pH ranges from 5.5 to 6.0. 12 to 36 inches thick.

Some Important Soil Limitations and Interpretations

Soil 83 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Engineering

1. Failure and Erosion of Road Waste and Fills - is a moderate to severe problem. The soil and bedrock factors, along with steep topography, result in considerable raveling and sloughing. When this occurs near streams, it provides sediment that may be damaging to the water resource.

2. Considerations for Road Location and Construction - The steep and dissected topography requires considerable excavation and causes poor road alignment. There is potential for damage to the soil and water resources for road-caused slides.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is too steep (greater than 35 percent) to be tractor operable without the potential for causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - This method has the potential for causing moderate to severe damage depending upon such factors as steepness of slope, frequency of dissections, and the design and frequency of access roads. The steep dissected topography often permits logs to become temporarily airborne prior to slamming into and gouging the soils. This may cause soil displacement that allows soils to be vulnerable to erosion damage. Much of the total damage may be related to the access roads. Roads may cause considerable soil exposure on cutslopes and wasteslopes that are subject to erosion and sloughing. This causes soil loss and when occurring near streams there is potential for damage to water quality and fisheries.

   c. Fully Suspended Cable System - This method can be expected to cause little or no soil damage from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as previously indicated.

2. Engineering Practices

   Roads have a moderate to severe impact potential on soil and water values with the greatest potential occurring at or near streams and on slopes over 60 percent. A major impact is from excavation waste when sidecast. Sidecast material often ravels and sloughs and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 90

Mapping Unit 90 consists of intrusive igneous and gneissic rock outcrop with minor amounts of schist rock outcrop. The most common inclusions are Soils 5, 6, 7, 8, 91 and 92.

Bedrock is generally competent and moderately to highly fractured.

This mapping unit occurs on ridgecrests and steep sideslopes.

MAPPING UNIT 91

Mapping Unit 91 consists of Soil 91 and inclusions of other soils. The most common inclusions are Soils 92, 90 and 15.

Mapping Unit 91 is similar to Mapping Unit 92 with the exception of landform and inclusions.

Soil 91 is a shallow to moderately deep (commonly 1-4 feet), nonplastic soil derived from residuum and colluvium. Surface soils are generally thin loamy sands. Subsoils are generally thin gravelly sandy loams or gravelly loamy sands.

Bedrock is moderately competent to competent, moderately to highly fractured intrusive igneous, gneissic or metamorphic rock.

Typically, Soil 91 occurs on steep, smooth, slightly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 6,500 feet and supports Douglas-fir, white fir, true fir, alpine fir and western larch. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 91

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface Layers - Very dark grayish brown to brown loamy sand to sandy loam; single-grained; 10 to 35 percent subround gravel by volume; nonsticky, nonplastic; pH ranges from 5.0 to 6.0. 6 to 15 inches thick.

Subsoil Layers - Dark brown to yellowish brown, very gravelly loamy sand, ranging to very gravelly sandy loam; single-grained; 45 to 70 percent subround gravel and cobbles by volume; nonsticky, nonplastic; pH ranges from 5.0 to 6.0. 6 to 21 inches thick.

Some Important Soil Limitations and Interpretations

Soil 91 has the following important limitations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Timber Management

1. Limitations to Regeneration and Tree Growth - Limitations are present that increase with elevation, especially as they affect Douglas-fir. Severe limitations occur at the higher elevations because of shorter growing season and cold, infertile soils.

2. Planting Species - Soil and climatic factors along with observations indicate that true fir or larch plantings are better adapted to the higher elevations than Douglas-fir. Less intensive management would be required to ensure survival and growth.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is generally too steep (greater than 35 percent) to be tractor operable without the potential of causing excessive soil damage. (See "Common Soil Problems.")

   b. Partially Suspended Cable System - The potential for soil damage is low to moderate, depending upon such factors as steepness of slope, proximity of streams, and the design and frequency of access roads. (See "Common Soil Problems.")

   c. Fully Suspended Cable System - Little soil damage would be expected from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as indicated under "Engineering Practices."

2. Engineering Practices

   Roads have a low to moderate potential impact on soil and water values, with the greatest impact potential occurring at or near streams and on slopes over 60 percent. A primary impact is from excavation waste when sidecast on the steeper slopes. Raveling and erosion of cutbanks often occur which can be difficult to control with standard erosion control practices. Excavation waste that reaches streams may be damaging to water quality and fisheries.

MAPPING UNIT 92

Mapping Unit 92 consists of Soil 92 and inclusions of other soils. The most common inclusions are Soils 91, 90 and 9.

Mapping Unit 92 is similar to Mapping Unit 91 with the exception of landform and inclusions.

Soil 92 is a shallow to moderately deep (commonly 1-4 feet), nonplastic soil derived from residuum and colluvium. Surface soils are generally thin loamy sands. Subsoils are generally thin gravelly sandy loams or gravelly loamy sands.

Bedrock is moderately competent to competent, moderately to highly fractured, intrusive, igneous, gneissic or metamorphic rock.

Typically, Soil 92 occurs on very steep, highly dissected sideslopes of greater than 35-percent slope. This soil ranges in elevation from 3,000 to 6,500 feet and supports Douglas-fir, white fir, true fir, alpine fir and western larch. This soil is well drained. Permeability is rapid.

Range of Profile Characteristics of Soil 92

Litter - Needles, leaves, twigs and decomposing organic matter. 0.5 to 1.5 inches thick.

Surface Layers - Very dark grayish brown to brown loamy sand to sandy loam; single-grained; 10 to 35 percent subround gravel by volume; nonsticky, nonplastic; pH ranges from 5.0 to 6.0. 6 to 12 inches thick.

Subsoil Layers - Dark brown to yellowish brown, very gravelly loamy sand ranging to very gravelly sandy loam; single-grained; 45 to 70 percent subround gravel and cobbles by volume; nonsticky, nonplastic; pH ranges from 5.0 to 6.0. 6 to 36 inches thick.

Some Important Soil Limitations and Interpretations

Soil 92 has the following important limitations and interpretations:

Watershed

Surface Erosion - This soil has the potential for severe surface erosion when the protective duff and vegetative cover is removed. (See "Common Soil Problems.")

Timber Management

1. Limitations to Regeneration and Tree Growth -Limitations are present that increase with elevation, especially as they affect Douglas-fir. Severe limitations occur at the higher elevations because of shorter growing season and cold, infertile soils.

2. Planting Species - Soil and climatic factors, along with observations, indicate that true fir or larch plantings are better adapted to the higher elevations than Douglas-fir. Less intensive management would be required to ensure survival and growth.

Selected Soil and Water Impacts from Certain Management Practices

1. Timber Harvest Methods

   a. Tractor - This mapping unit is too steep (greater than 35-percent) to be tractor operable without the potential for causing excessive soil damage. (See"Common Soil Problems.")

   b. Partially Suspended Cable System - This method has the potential for causing moderate to severe damage depending upon such factors as steepness of slope, frequency of dissections, and the design and frequency of access roads. The steep, dissected topography often permits logs to become temporarily airborne prior to slamming into and gouging the soils. This may cause soil displacement that allows soils to be vulnerable to erosion damage. Much of

the total damage may be related to the access roads. Roads may cause considerable soil exposure on cutslopes and wasteslopes that are subject to erosion and sloughing. This causes soil loss and, when occurring near streams, it is potentially damaging to water quality and fisheries.

   c. Fully Suspended Cable System - This method can be expected to cause little or no soil damage from the actual harvest operation. However, damage may be caused by access roads and would involve the same factors as previously indicated.

2. Engineering Practices

Roads have a moderate to severe impact potential on soil and water values with the greatest potential occurring at or near streams and on slopes over 60 percent. A major impact is from excavation waste when sidecast. Sidecast material often ravels and sloughs and is often difficult to stabilize. Excavation waste that reaches streams may be damaging to water quality and fisheries.

APPENDIX I

SOILS OF THE AREA

Many soils with different characteristics were recognized in the survey area. Between certain soils the differences are comparatively minor, while between others, the differences are major.

Soil differences result from variations in one or more of the soil-forming processes, five of which are recognized in soil formation. These processes include climate, vegetation, time, topography, and parent material. Of these, the two that have the most significance at the level of soil identification in this survey are parent material and topography. Soils that have the same kinds of topography and parent materially generally have many characteristics in common and have relatively minor differences. These soils can be placed in the same general group based on these two soil-forming processes. The common soil groups in the area are as follows:

Shallow to Moderately Deep Residual and Colluvial Soils

These soils characteristically exhibit little morphological development, are generally shallow to moderately deep (2-5 feet), weakly-structured, well drained, gravelly medium to moderately coarse textured, and are derived from a wide variety of hard to moderately hard rock types including volcanics, sedimentary and granitics. These soils are extensive and occur on ridgetops and sideslopes that are unaffected by glacial deposits. Some of the major mapping units representative of this group are 31, 32, 61, 63, 71, 81 and 91.

Moderately Deep to Very Deep Residual and Colluvial Soils

These soils have a wide variability in texture and depth. They are separated into two subgroups as follows:

Subgroup I - These soils are moderately deep to very deep (5-12 feet), weakly structured, well to moderately well drained, and contain textures throughout the profile that range from moderately coarse to moderately fine. Textures are often highly variable from one location to the next. These soils are underlain by moderately to highly weathered pyroclastic bedrock. They occur on many benchy toeslopes and sideslopes throughout the area. Mapping Units 36, 37, 42 and 43 include soils of this subgroup.

Subgroup II - These soils are characteristically deep to very deep, weakly to moderately structured, moderately to imperfectly drained, and moderately fine to fine textured. These soils are underlaid by highly weathered pyroclastic or sedimentary bedrock. These soils are unstable, especially on steeper slopes. They occur on uneven toeslopes and sideslopes. Mapping Units 38, 44, 45, 46 and 75 include soils of this subgroup.

Deep, Glacial Soils

These soils are characteristically very deep (12 feet +), weakly structured, and well to moderately well drained. Textures are generally gravelly and

cobbly, medium to moderately coarse throughout with stones often present throughout the profile. Weak to moderate compaction may be present in the subsoils. These soils are comprised of glacial till, drift and outwash deposits which have often been modified by colluvial action (gravitational influences). These soils are found in numerous locations in valley bottom and on valley sideslopes throughout the area. Mapping Units 10, 11, 12, 13, 14 and 15 include soils of this group.

APPENDIX II

VEGETATION

Vegetation patterns on the east side of the Cascade Crest are often distinct and contrasting, especially toward the eastern foothills. Elevation, length of growing season, aspect, temperature, soils, and available moisture are the major factors that influence vegetation kind and distribution.

Extending eastward from the Cascade Crest, there is an average decrease in both elevation and precipitation, 1/and an increase in summer temperatures. These factors cause major changes in vegetative types.

In the upper elevations toward the Cascade Crest, the effects of abundant moisture, heavy snowfall, cold winter temperatures and short growing seasons are strongly expressed throughout broad areas with minimal influence from moderate elevation changes and aspect differences. The result is that vegetation is affected similarily over broad areas and, consequently, vegetative changes are comparatively subtle.

Extending further eastward, the reduction in moisture and increased summer temperatures, as modified by aspect and topography, become increasingly effective in the determination of vegetative patterns and types. At the lower elevations towards the eastern foothills, moisture becomes very limiting for growth. Vegetation occurs that is adaptable to the moisture available. The annual precipitation is much lower than at higher westward elevations, and the summer temperatures are much warmer with high rates of evapotranspiration. Here, the influence of aspect becomes of major importance. Northern exposures are cooler with lower evapotranspiration rates and can often support vegetative types that are unable to survive on the hot, droughty southern slopes. Consequently, vegetation patterns are often distinct and abruptly change with variations of aspect and topography.

Five broad vegetative groups were observed and used as additional criteria for developing different mapping units. The vegetative groups are listed as follows:

Vegetative Group	General Grouping	Overstory Species
A	Bunchgrasses and brush	None
B	Open ponderosa pine, brush and grass	Ponderosa pine
C	Ponderosa pine/Douglas-fir	Ponderosa pine, Douglas-fir
D	Mixed conifers	Ponderosa pine, Douglas-fir, western larch, western white pine, white fir, silver fir, western hemlock
E	Alpine species	Engelmann spruce, subalpine fir, mountain hemlock, whitebark pine

1/See Isohyetal Map, page 141.

Figure 14 below depicts the general relationship between climate, major overstory species, vegetative groups and mapping units. The vegetative groups and mapping units were developed for the purpose of this Soil Resource Inventory.

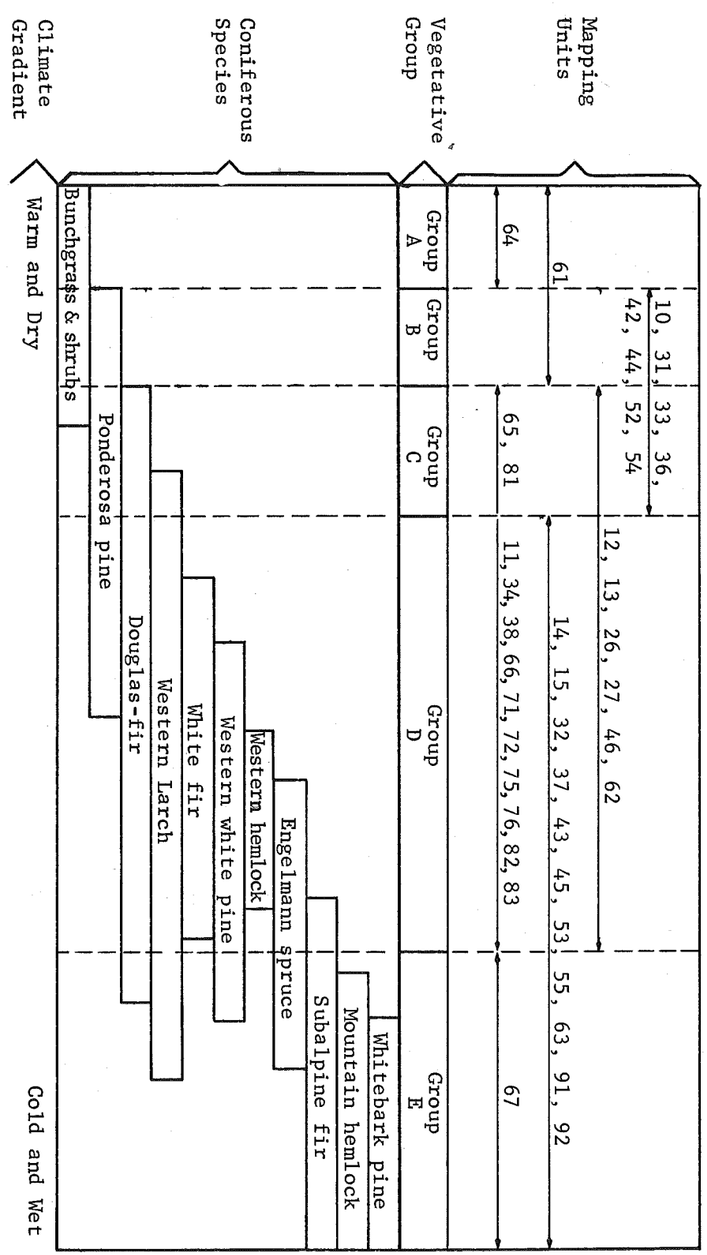
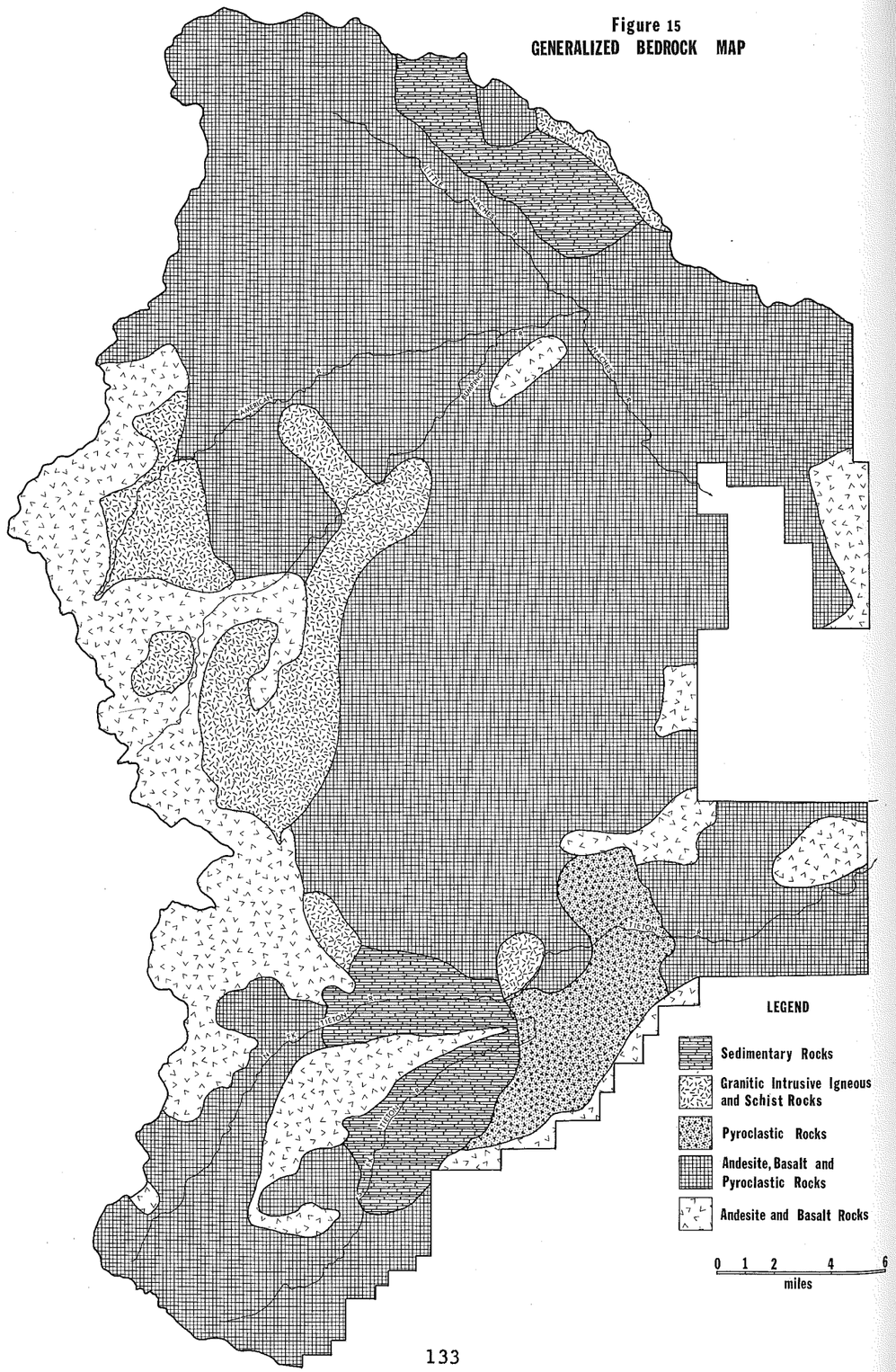


Figure 14

Figure 15
GENERALIZED BEDROCK MAP



APPENDIX III

GENERALIZED GEOLOGY OF THE AREA 1/ 2/

The bedrock of the survey area is composed of the following major types of rocks: andesites and basalts, pyroclastics, sedimentary (both marine and nonmarine), granitic and schist. Of these, the most predominant rocks are the andesites, basalts and pyroclastics. These rocks occur both separately and intermixed, and constitute over 70 percent of the survey area. The remaining area is approximately equally divided among the other rock types with the exception of the schist rocks which are of very minor extent.

The schist rocks are the oldest in the area and are Jurassic in age. Most of the other rocks date to the early or middle Tertiary period, with only a few of the basalt and andesite flows having occurred later than the Pliocene epoch.

Andesite and Basalt-Rocks - These rocks are fine-grained, generally hard and competent, and usually highly fractured (Figure 16). In the extreme eastern locations they exhibit columnar fracturing; while, elsewhere, platy fracturing is more common. Colors range from pinkish gray to black. These rocks are among the most resistant in the area and often cap ridges and plateaus that are underlaid by the less resistant pyroclastic rocks. However, in some areas they predominate from ridgetop to valley bottom, and are also found in some areas intermixed with hard pyroclastics.



These rocks are hard and often highly fractured.

Figure 16. Andesite Bedrock

1/ Division of Mines and Geology; Geologic Map of Washington, 1961.

2/ The Geologic Map of Washington was used as a general field guide for the development of this Bedrock Map; however, the Geologic Map of Washington differs somewhat from the Bedrock Map because of field observations. Many of the bedrock types shown on the Geologic Map had sufficient similarities to enable them to be grouped together into broader groups that would both simplify the Bedrock Map and satisfy the survey requirements of best fitting the map to the purpose of the soil interpretations.

These rocks include Qv, PQv, Mv and portions of EQv and QMx as shown on the Geologic Map of Washington. Soils either partially or completely derived from these rocks are Mapping Units 50 through 55 and 60 through 67. The largest continuous areas occur in the extreme eastern portions of the Districts. Elsewhere they commonly occur closely associated with less resistant pyroclastic rocks.

Pyroclastic Rocks - This is a broad class of rocks whose primary fragments originated as explosive volcanic ejecta. After deposition, this material was subjected to one of several possible processes. Much that fell on bodies of water settled to the bottom and later became consolidated. Other volcanic ejecta may have become involved in mudflow activity that incorporated the ejecta with pre-existing soil and rocks which later solidified and hardened to form pyroclastic rocks.

Other processes also can occur. Because of the various ways that pyroclastics can form, there is wide variety in their appearance and properties (Figures 17, 18 and 19).

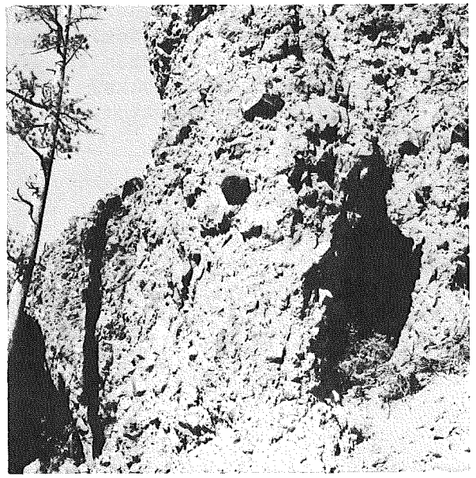


Figure 17. Pyroclastic Bedrock.

This is an example of moderately hard, relatively unfractured mudflow breccia. The bedrock is composed of various-size rock fragments.

This is an example of water-laid pyroclastics which are common to Mapping Units 33 and 34. This rock is soft to moderately hard and ravels extensively.



Figure 18. Pyroclastic Bedrock.



Most of the rock in this picture is soft. It is highly fractured, ravels extensively, and is subject to mass failures, especially when occurring on steep, dissected slopes.

Figure 19. Pyroclastic Bedrock.

In general, the pyroclastic rocks have little resistance to weathering and are often associated with unstable soils. As a group they are moderately hard to soft and moderately competent to incompetent, although a minor amount does occur that is hard and competent. These rocks are generally highly fractured and usually lack definite fracture patterns. Colors are variable and may be whitish gray, tan, red, yellow, blue gray or black. Often incorporated within the pyroclastic rocks are basaltic fragments. Many of the pyroclastics have been weathered so extensively that they are no longer recognizable as rock.

These rocks include EQv, QMv, MPc and Ev_1r as shown on the Geologic Map of Washington. Soils either partially or completely derived from these rocks are Mapping Units 31 through 46, and 50 through 55. The pyroclastic rocks in Mapping Units 50 through 55 are hard to moderately hard and are intermixed with andesites and basalts.

The pyroclastic rocks are widespread throughout the survey area. They occur both in large continuous areas and in areas closely associated with andesites and basalts.

Sedimentary Rocks - Two classes of sedimentary rocks occur in the survey area. One class consists of marine sedimentary rocks that have experienced some metamorphism and alteration that has changed the original rock characteristics. In general, the rocks in this class include bedded graywacke, argillite and shale. These rocks are generally hard and competent except locally in some depressional or drainage areas where they are moderately hard to soft and range from moderately competent to incompetent. They are moderately to highly fractured. Colors are predominately light gray to dark gray, but other colors include light brown to dark red.

These rocks are shown as PE_2 on the Geologic Map of Washington. Soils derived from these rocks are Mapping Units 81, 82, 83 and 75. They occur primarily near Rimrock Lake and up the South Fork of the Tieton River.

The second class of sedimentary rocks consists primarily of nonmarine, thinly-bedded sandstone, siltstone and mudstone (Figure 20). These rocks are generally moderately hard and moderately competent except locally in some depressions or drainages where they are soft and incompetent. Weathering is generally slight to moderate in the coarse-textured rocks, while the fine-textured mudstone and siltstone may exhibit local deep, intensive weathering. These rocks are generally highly fractured with colors predominately of light gray, tan or brown.

These rocks are shown as Ec on the Geologic Map of Washington. Soils derived from these rocks are included within Mapping Units 71, 72, 75 and 76. They are primarily located in the Quartz Creek-Pileup Creek area on the Naches Ranger District.



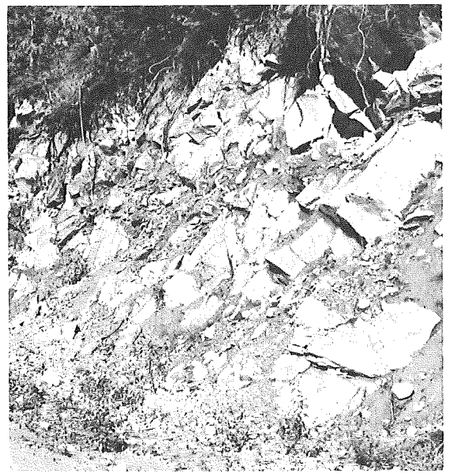
The bedrock in this picture consists of highly-fractured and moderately hard-bedded sandstone and siltstone.

Figure 20. Sedimentary Bedrock.

Granitic Intrusive Igneous and Schist Rocks

The granite rocks are coarse-textured and are generally hard and competent. They are massive to moderately fractured (Figure 21). Colors range from dark gray through pinkish gray to white. Occurring locally are brecciated granites that are moderately hard to soft and moderately competent to incompetent.

The schist rocks are generally hard and competent except in drainages where they may be only moderately hard and competent. Thin veins of quartz and granodiorite are commonly present. Colors are predominately black to bluish black except white to reddish in veins (Figure 22).



This rock is very hard and coarse-textured. It often fractures into large blocks.

Figure 21. Granitic Bedrock.

Schist characteristically exhibits a warped and striated appearance.



Figure 22. Schist Bedrock

These rocks are shown as Tg, Ti (granitic), and PJsc (schist) on the Geologic Map of Washington. Soils derived from these rocks are included within Mapping Units 91 and 92. The granitic rocks occur north of Rimrock Lake, in the area of Bumping Lake and locally elsewhere. The schist rocks are very minor in extent and occur in a narrow stringer adjacent to the northern boundary of the Naches Ranger District.

Volcanic Ash

Most of the area within the Naches and Tieton Ranger District boundaries has received volcanic ash influence in recent geologic history (probably from Mt. Mazama, Mt. Rainier and unknown sources) as indicated by a thin layer of surface ash, or ash incorporated with the surface soil layers. Unincorporated ash layers range in thickness from 0 to 6 inches. The ash ranges in texture from sand to sandy loam, and ranges in color from gray to dark yellowish brown.

Glaciation

Glaciation has not been significant throughout the entire mapping area. However, it has exerted a major influence in the western third with the most extensive glaciation having taken place in the Bumping Lake - Chinook Pass area. Also, there has been glaciation extending down the South Fork and North Fork of the Tieton River from the Goat Rocks. The Goat Rocks still maintain a few small alpine glaciers. Cirque basins, small lakes, oversteepened sideslopes, hanging valleys and broad U-shaped valleys are characteristic of the previous glacial modification.

APPENDIX IV

CLIMATE [1/]

The climate on the Tieton and Naches Ranger Districts is primarily influenced by terrain, prevailing westerly wind, distance and direction from the Pacific Ocean and lee slope location. The Cascades rise to elevation of 5,000 to 7,000 feet and obstruct the easterly movement of moist air from the ocean.

During the fall and winter, a circulation of air around the high and low pressure centers over the North Pacific brings a prevailing flow of warm, moist air from a southwesterly direction into western Washington. As the moist air rises along the western slope of the Cascades, cooling and condensation occur, causing heavy precipitation along the windward slope and near the summit. The descending air along the eastern slope becomes warmer and drier, resulting in a decrease in precipitation along the lee slope. The reduction in moisture, combined with continental air from the interior, results in a modified continental climate with wide temperature extremes.

The wet season in the higher elevations begins about the first of October, reaches a peak in winter, then gradually decreases in the spring. Along the eastern slope, annual precipitation decreases from approximately 100 inches at the summit, to 48 inches at Bumping Lake, and to 27 inches at Rimrock Dam.

Winter Conditions - At elevations ranging from 3,000 to 4,500 feet above sea level, snowfall can be expected in October; however, it generally does not accumulate on the ground until after the first of November. The depth of snow on the ground increases until after the first of March. At Bumping Lake, the maximum depth on the ground, 158 inches, was recorded on March 10, 1956. The winter season snowfall near the summit of the Cascades ranges from 300 to 500 inches and snow depth ranges from 10 to 25 feet. In the vicinity of Bumping Lake, snow remains on the ground until after the first of May, and at the higher elevations until the last of June.

In the winter season, afternoon temperatures range from 25^{o} to 35^{o} and nighttime readings range from 10^{o} to 20^{o}. Minimum temperatures drop to zero or lower on a few nights almost every winter; to -10^{o} in one out of two winters, and occasionally to -20^{o} or lower.

Summer Conditions - A prevailing westerly and northwesterly flow of comparatively dry and stable air into Washington in the late spring and summer results in a dry season beginning in May and reaches a peak in midsummer. During July and August it is not unusual for three to six weeks to pass with but a few rain showers. Cumulus clouds frequently develop over the mountain in the afternoon and disappear after sunset. Thunderstorms occur on 10 to 15 days each summer.

Afternoon temperatures in the warmest summer months at Bumping Lake (elevation 3,440 feet) are in the 70's and nighttime readings are in the 40's. Minimum temperatures drop to near or slightly below freezing on a few nights almost every summer. Maximum temperatures reach the upper 80's and

1/ This information and data were taken from "Climatological Summaries" by the U.S. Department of Commerce Weather Bureau.

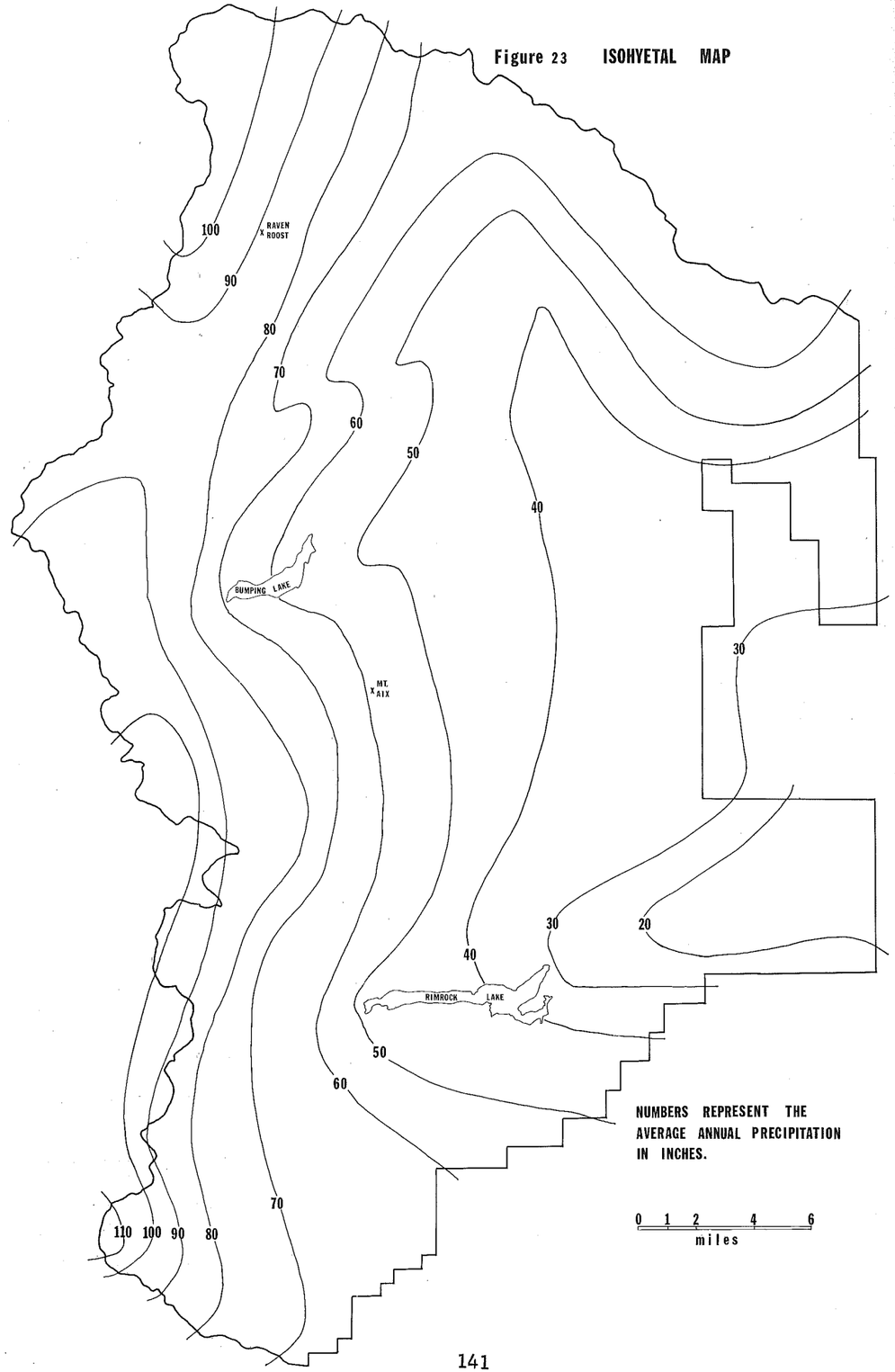


Figure 23 ISOHYETAL MAP

lower 90's on a few afternoons. A cool mountain breeze in the late afternoon results in rapid cooling after sunset. The average relative humidity ranges from about 30 percent in the afternoon to 70 percent or higher at night. Temperatures can be expected to decrease approximately three degrees with each 1,000-foot increase in elevation.

Temperatures in the warmest months at the Tieton Intake (elevation 2,880 feet) average in the 80's, with several days in the 90's and low 100's. Minimum nighttime temperatures average near 50° during the warmest months.

Table of Mean Temperature and Precipitation Data

This table includes data from U.S. Weather Bureau Stations on and adjacent to the Naches and Tieton Ranger Districts of the Snoqualmie National Forest. The Bumping Lake, Rimrock-Tieton Dam, and Tieton Intake stations are within the survey area boundaries. Both the Stampede Pass and Yakima stations are located outside the survey area boundaries.

Bumping Lake — Elevation: 3,440 feet; Period: 1931 - 1941

Month	Mean Temperature (°F)	Precipitation (Inches)
January	23.1	7.85
February	26.5	6.03
March	30.9	4.82
April	38.1	2.29
May	45.6	1.77
June	50.9	1.59
July	58.2	.53
August	57.7	.64
September	51.9	1.52
October	43.0	4.28
November	32.3	7.25
December	26.6	9.25
Annual	40.4	47.82

Rimrock Tieton Dam — Elevation: 2,730 feet; Period: 1951 - 1960

Month	Mean Temperature (°F)	Precipitation (Inches)
January	26.3	5.20
February	30.9	2.94
March	33.8	2.41
April	42.6	1.20
May	50.4	.88
June	56.2	.73
July	63.6	.37
August	61.7	.60
September	56.3	.75
October	46.4	2.60
November	34.6	4.29
December	29.8	5.04
Annual	44.4	27.01

Stampede Pass — Elevation: 3,958 feet; Period: 1921 - 1950

Month	Mean Temperature (°F.)	Precipitation (Inches)
January	23.7	13.05
February	27.0	11.07
March	30.7	10.60
April	37.1	5.50
May	44.5	4.74
June	50.4	3.97
July	56.9	1.29
August	56.6	2.08
September	51.2	4.04
October	42.4	9.34
November	31.6	13.26
December	26.2	14.66
Annual	39.9	93.60

Tieton Intake — Elevation: 2,280 feet; Period: 1951 - 1960

Month	Mean Temperature (°F)	Precipitation (Inches)
January	25.7	3.52
February	30.9	1.97
March	34.8	1.72
April	43.8	1.22
May	51.7	1.00
June	58.0	.79
July	65.4	.51
August	63.4	.57
September	57.1	.57
October	46.1	1.57
November	33.5	2.60
December	28.9	3.36
Annual	44.7	19.40

Yakima — Elevation: 1,061 feet; Period: 1921 - 1950

Month	Mean Temperature (°F)	Precipitation (Inches)
January	26.9	.96
February	34.2	.81
March	43.7	.46
April	51.4	.43
May	59.1	.47
June	65.4	.59
July	71.4	.18
August	69.5	.22
September	61.1	.39
October	50.6	.62
November	38.1	.98
December	30.6	1.10
Annual	50.2	7.21

APPENDIX V

DEFINITIONS OF MANAGEMENT INTERPRETATIONS

This appendix contains the definitions for the soil and management interpretations found in the Atlas under "Tables of Management Interpretations." Definitions apply to Erosion and Some Hydrologic Interpretations, Timber Management, Engineering, Recreation, and Range and Wildlife Management.

EROSION AND SOME HYDROLOGIC INTERPRETATIONS

Erosion and some hydrologic interpretations include erosion and water management interpretations. Interpretations for erosion include the two major kinds of erosion--surface and mass movement. Surface erosion pertains only to surface soil loss by runoff and overland flow. Mass movement pertains to all types of soil and bedrock movement which occurs below the soil surface such as landslips, slumps, slides, rockfall and landflow.

Natural Stability

This rating is based on the relative stability of the mapping units as they occur in the natural state. This includes any movement or loss other than surface erosion by slumps, slides and all kinds of deep-seated failures. This rating applies throughout Region 6.

I. Very stable - No evidence of failure.

II. Stable - Occasional failures are observed.

III. Moderately stable - Several failures are observed.

IV. Unstable - Many failures are observed.

V. Very unstable - Entire area shows evidence of recent and past failures.

Nature of Mass Movement

This is an estimate of the kind and/or size of mass movement observed.

Expected Mass Movement as a Result of Man's Activities

This rating indicates the expected mass movement resulting from man's activities as compared to stability under natural conditions. Ratings are based on soil and bedrock characteristics, slopes, revegetation potential, and effects of timber removal, road construction and fire.

Unchanged - The expected mass movement is relatively unchanged from that of the natural state.

Increased - The expected mass movement is greater than that of the natural state.

Greatly Increased - The expected mass movement is much greater than that of the natural state.

Surface Erosion Potential

This rating is based on expected losses of surface soil when all vegetative cover, including litter, is removed. Evaluations of climate, slope gradient and length, soil characteristics, hydrologic characteristics of the soil and bedrock materials of each mapping unit are considered in making ratings.

Very slight - Practically no loss of surface soil materials is expected.

Slight - Little loss of soil materials are expected. Some minor sheet and rill erosion may occur.

Moderate - Some loss of surface soil materials can be expected. Rill erosion may be occurring. Sheet erosion can be determined by some soil pedestals and observable accumulation of soil materials along the up-slope edge of rocks and debris. At this level of erosion, there is a possible fertility loss.

Severe - Considerable loss of surface soil materials can be expected. Rill erosion, numerous small gullies or evidence that considerable loss from sheet erosion may occur. Sheet erosion is indicated by frequent occurrence of soil pedestals and considerable accumulation of soil materials along the up-slope edge of rocks and debris. This is accompanied by a probable fertility loss.

Very severe - Large loss of surface soil material can be expected in the form of many large gullies and/or numerous small gullies or large loss from sheet erosion. Sheet erosion loss is exhibited by numerous examples of soil pedestals and extensive accumulation of soil materials along the up-slope edge of rocks and debris. This is accompanied by a fertility loss.

Subsoil Erosion Potential

This interpretation indicates the potential for subsoil erosion by water for each unit. It includes erosion which takes place after the surface soil has been removed (about 1-foot depth) such as in skid trails and firebreaks. Factors considered in making ratings are texture and structure of subsoil materials, slope, permeability, compaction, climate, and landform.

Low - Factors are such that little or no erosion may occur. Very little evidence of erosion.

Moderate - Considerable erosion occurring such as rills and small gullies. Factors indicate considerable erosion is likely to occur.

High - Factors indicate severe erosion may occur.

Suggestions for Controlling Subsoil Erosion

In this column, suggestions are given, when applicable, for controlling subsoil erosion.

Water Yield Class

This interpretation is an indication of the rate and amount of water yield expected from each soil. It is based on factors such as soil characteristics, infiltration rates, permeability, slope, climate, vegetation, and drainage patterns.

Class I - These soils have a high water detention storage capacity and a low rate of runoff. Little water is yielded to peak flows until detention storage capacity is exceeded or unless the soils are initially saturated or frozen. They are important in sustaining high base flow due to a relatively large volume of water held in detention storage.

Class II - These soils have a moderate water detention storage capacity and a moderate rate of runoff. Water contributes to both peak flows and base flow.

Class III - These soils have a low water detention storage capacity and a high rate of runoff. The storage capacity is low and easily exceeded with most of the water contributing to peak flow. Little water is yielded to sustain base flow.

Bedrock Hydrologic Characteristics

This interpretation indicates the relative capacity of bedrock to store and transmit water. The rating is based on bedrock kind, texture, type and extent of fracturing, frequency of jointing, bedding characteristics, and degree of weathering.

Class I - This indicates that the bedrock has a relatively high capacity to store water. The water transmission rate is low unless the storage capacity is exceeded. Rocks in this class include sandstones because of their texture, fracture and bedding characteristics; and basalts where water occurs in large tubes and other cavities or in the interflow zone between successive lava flows.

Class II - This indicates that the bedrock has a moderate capacity to store water. The rate of water transmission is moderate. Rocks in this class are generally hard to moderately hard, moderately fine-textured, and moderately- to highly-fractured siltstone, mudstone, pyroclastics, argillite and schist.

Class III - This indicates that the bedrock has a relatively low capacity to store water. The rate of water transmission is rapid. Rocks generally in this class are fractured coarse crystalline (i.e., granite, gabbro and gneiss) and other hard-fractured rocks such as conglomerate.

Class IV - This indicates that the bedrock has both low-storage capacity and low rate of water transmission. Rocks in this class are generally highly weathered, fine textured, and lack open fracture channels.

Hydrologic Group

This interpretation is a grouping of soils into four classes, indicating the general infiltration and water movement ability of the soil and bedrock materials. This method of ratings has been developed by the Soil Conservation Service. The four groups are the standard SCS groupings and definitions.

Group A - Soils having high infiltration rates, even when thoroughly wetted, consisting chiefly of deep, well to excessively drained sands and/or gravel. These soils have a high rate of water transmission and would result in a low runoff potential.

Group B - Soils having moderate infiltration rates when thoroughly wetted, consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

Group C - Soils having slow infiltration rates when thoroughly wetted, consisting chiefly of (1) soils with a layer that impedes the downward movement of water, or (2) soils with moderately fine to fine texture and a slow infiltration rate. These soils have a slow rate of water transmission.

Group D - Soils having very slow infiltration rates when thoroughly wetted, consisting chiefly of (1) clay soils with high swelling potential, (2) soils with a high permanent water table, (3) soils with claypan or clay layer at or near the surface, and (4) shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission.

Sedimentation Yield Potential

This interpretation indicates the potential for water sedimentation and pollution from silt and clay particles carried in suspension following timber harvest, road construction, or other activities. Factors considered in making ratings are soil texture and structure, drainage patterns, landform and climate.

Low - Sedimentation levels of silt and clay particles are not expected to be significant following management activities. Soils are generally moderately coarse-textured.

Moderate - Sedimentation levels of silt and clay particles may be significantly increased following management activities with moderate loss of water quality and damage to fisheries. Soils are generally medium-textured.

High - Sedimentation levels of silt and clay particles are expected to be high following management activities. Streams become turbid and there is considerable loss of water quality and damage to fisheries. Soils are generally fine to moderately fine-textured.

Expected Sediment Size

This interpretation indicates the expected sediment size reaching the streams resulting from erosion of each unit. This interpretation is a statement of the two dominate separates expected (gravel, sand, silt or clay) from each soil unit. The ratings are presented in two columns. The first column indicates the separates expected from the subsoils.

Water/Resource Management Requirements

This interpretation indicates the relative level of management necessary to maintain high water standards in relation to quality, quantity and temperature. This interpretation also pertains to fishery values as affected by these water standards, and also to stream damage resulting from sidecast waste and/or slides caused by management activities.

Low - This rating indicates that the management requirements necessary to maintain high water and fishery values are basic. The standard Forest Service protective measures are usually adequate.

Moderate - This rating indicates that more intensive management practices are needed than are commonly in use in order to maintain high water and fishery values. Measures required may include some or all of the following: intensive water bars on roads and trails, wet weather suspension on cat and tractor operation, restricted operation with cat or tractor blade, wet weather suspension on road construction, end hauling of surplus waste, and use of suspended cable logging systems.

High - This rating indicates that very intensive protective measures are required to maintain high water and fishery values. These include such measures as the following: use of suspended cable logging systems, minimum road density, minimal frequency of spur roads, strict requirements of surplus waste end hauling, suspended road construction during wet weather, intensive water barring and revegetation programs, and a critical analysis of cutting levels. This rating also includes soils of such a critical nature that present management techniques are not adequate.

TIMBER MANAGEMENT

Interpretations for timber management are of two types. One type includes some interpretations that directly affect timber management, such as "windthrow hazard" and "potential for regeneration." The other type indicates the effect on soils and other resources from timber harvest activities.

Soil and Watershed Impacts from Various Timber Harvest Methods

This interpretation indicates the susceptibility of soil and watershed resources to incur damage from various timber harvest methods. Each soil is evaluated as to the expected impact from each of the following harvest methods: Tractor logging, cable (no suspension), cable (partial suspension), cable (full suspension), and aerial logging. The evaluation of expected impact includes soil and watershed resource damages from timber removal, main access roads, spur roads, landings and other activities that may be associated with the harvest method being evaluated. The evaluations are based on a full operating season. Damage is caused to soils by creating soil disturbance which may destroy soil structure, cause compaction and increase erosion. This may affect other resources through loss of production, lower water quality and yield, and loss of fisheries. Factors involved in making these ratings are wetness of soil, soil texture and structure, percentage of coarse fragments, slope, drainage, climate, and field observations.

Low - This rating indicates that the impacts to soil and watershed resources are minor. Little or no soil damage is expected.

Moderate - This rating indicates that the impacts to soil and watershed resources are moderate. Soils and watershed resources are expected to incur moderate damage.

High - This rating indicates that the impacts to soil and watershed resources are major. Excessive damage to soil and watershed resources is likely to occur.

Type of Damage Expected During and Subsequent to Timber Harvest Operations

This indicates the type of soil and watershed resource damage expected on each soil from various harvest methods.

Potential for Douglas-fir Regeneration

This interpretation indicates the potential for each mapping unit to regenerate Douglas-fir to a satisfactory stocking level as set by the Forest Service. Factors included in this interpretation are soil characteristics, climate, aspect, elevation, frost potential, brush competition, and tree species.

Low - This rating indicates the potential for Douglas-fir regeneration is low. Probability of success is very limited. Major regeneration problems can be expected and re-seeding or replanting may be required throughout the area. Several years may elapse before a satisfactory stocking level is achieved.

Moderate - This rating indicates that some problems will be encountered in attaining a satisfactory stocking level. Usually Douglas-fir regeneration is spotty and some replanting will be necessary.

High - This rating indicates that Douglas-fir regeneration has a high probability of success. Few problems should be encountered in attaining satisfactory stocking levels.

Limits to Regeneration

This indicates the major limitations to regeneration.

Windthrow Hazard

This interpretation indicates the general susceptibility to windthrow for each mapping unit. This interpretation is based solely on the soil factors listed below. The ability of a particular tree species to resist windthrow is not considered. Windthrow hazard ratings are based on such factors as texture, soil depth, water table, and effective rooting depth, and are considered individually or in combination.

Low - Factors indicate windthrow is not likely. The effective rooting depth is generally greater than 36 inches.

Moderate - Factors indicate some susceptibility to windthrow, but major problems are not likely. The effective rooting depth is generally between 18 and 36 inches.

High - Factors indicate that windthrow hazard is high. The effective rooting depth is generally less than 18 inches.

Susceptibility to Brush Revegetation

This indicates the susceptibility of mapping units to revegetate naturally by brush following clearcut timber harvest. These ratings are based on soil characteristics, field observation, slope, aspect, climate, and elevation.

Low - Indicates brush revegetation is insignificant.

Moderate - Indicates that some brush revegetation will occur.

High - Indicates brush revegetation is severe.

Susceptibility to Pinegrass Revegetation

This interpretation indicates the susceptibility of mapping units to revegetate to pinegrass following timber harvest operations. These ratings are based on soil characteristics, drainage, elevation, climate, topography position and field observations.

Low - Factors do not encourage pinegrass establishment and growth. Little or no pinegrass revegetation occurs.

Moderate - Factors are moderately favorable for pinegrass establishment and growth. Pinegrass revegetation is moderate.

High - Factors are highly favorable for pinegrass establishment and growth. Pinegrass revegetation occurs rapidly.

ENGINEERING

Interpretations for engineering include characteristics for roads, foundations, bedrock, and some miscellaneous interpretations. These are presented in two tables. One table, "Characteristics Pertinent to Roads and Airfields," is a standard engineering table for road construction based on the Unified Soil Classification System. The other table, "General Engineering Interpretations," gives other engineering interpretations which will be useful to engineers and other resource managers. These interpretations are explained and defined in this section.

Unified Classification

Each soil is classified as to its Unified Classification. Most soils will be classified into one class. Those soils with significant layers of different soil materials will have a classification for each layer designated. The classification will be made for some representative soils by laboratory testing. Those soils not tested will be classified by comparing their properties to those tested.

Generally, the following interpretations and ratings are based on the entire soil unit including soil, bedrock and landform. Some interpretations are based only on the soil material or bedrock material. These are stated in the description for each interpretation. The interpretations pertaining to roads are based on standard Forest Service regulations and construction methods presently used.

Suitability for Use as Topsoil Source

This rating evaluates each soil as to its suitability for use as topsoil. It does not specify any particular use of topsoil. Ratings are based on soil characteristics.

Suited - Soil texture ranges from sandy loam to clay loam and gravel content is less than 30 percent.

Unsuited - This rating indicates the soils do not satisfy the requirements specified under "Suited." However, soils rated "Unsuited" may still satisfy a particular requirement. See the "Table of Soil Characteristics" for soil texture, thickness and gravel content.

Suitability of Soil as Sand and/or Gravel Source

This interpretation indicates the suitability of each soil as a possible source of sand and/or gravel. It does not indicate the kind or quality of sand or gravel, or refer to any specific use of the sand and/or gravel.

Suited - This rating indicates that sand and/or gravel is present and the following conditions are satisfied: There is a layer present which is composed of 80 percent, by volume, of sand and/or gravel. This layer is at least 4 feet thick and has no more than a 5-foot overburden.

Unsuited - This rating indicates that sand and/or gravel is generally not present in amounts which satisfy the requirements under "suited." However, soils rated "unsuited" may still satisfy a particular requirement. See the "Table of Soil Characteristics" for soil depth and gravel content.

Suitability of Soil as a Possible Clay Source

This rating indicates the suitability of each soil as a possible source of clay. It does not indicate the kind or quality of clay or refer to any specific use of the clay.

Suited - This rating indicates that the soil is a possible source of clay. Soils with this rating have the following: texture ranges from clay loam to clay. Gravel content is less than 30 percent.

Unsuited - Soils with this rating generally are not possible sources for clay.

Suitability of Bedrock for Road Rock

This interpretation indicates the general stability of rock when used as road rock for base course or wearing surface. These ratings are based on rock hardness, density, and susceptibility to weathering and breakdown. Soils are not rated when depth to bedrock is greater than 12 feet.

Unsuited - Rock is soft and breaks down rapidly under logging traffic.

Poor - Rock is only moderately hard and breaks down easily under logging traffic, usually in one or two years' time.

Fair - Rock is hard and dense but tends to break down under logging traffic after about two to four years' use.

Good - Rock is hard, dense and resists breakdown under logging traffic.

Limitations of Bedrock for Road Rock

This column indicates the major limitation of the bedrock when used for road rock.

Estimate of Road Rock Thickness

This interpretation refers to estimated amount of road rock (base course and wearing surface) generally needed on heavy-vehicle, all-weather-use roads constructed on each soil. Factors involved in making this interpretation include observations, texture and plasticity of soil, depth of bedrock, drainage, and kind of subgrade the road generally will have--common material or bedrock. Ratings are based on uncompacted fills and on the use of high quality rock.

Cautionary Note: This information is for broad planning purposes only. Specific onsite characterization data are required to accurately determine thickness needs.

Very thin - Generally less than 6 inches.

Thin - Approximately 6 to 12 inches.

Thick - Approximately 12 to 24 inches.

Very thick - Generally over 24 inches.

Considerations for Road Location and Construction

This column indicates the major considerations for road location and construction through each soil. The rating evaluates the impact of road construction on other resources and/or road construction problems likely to be encountered.

Method of Excavation

This interpretation refers to excavation methods most used and commonly observed for each soil. This includes soil, bedrock and cemented and/or compacted layers in the soil. Methods are blading, ripping, and/or blasting.
Cautionary Note: These appraisals are subject to change as machinery capabilities change.

Subsoil Erosion Potential

This interpretation indicates the potential for subsoil erosion of each soil. Subsoil refers to that material from approximately the 5-foot depth extending to bedrock. It primarily includes erosion which takes place along road ditches and on cutslopes. Rating is of soil material only and does not apply when cutbank or ditch is in bedrock. Factors considered in making ratings are texture and structure of subsoil materials, permeability, compaction, and climate.

Low - Factors indicate that little or no subsoil erosion is likely to occur.

Moderate - Factors indicate that the subsoils have moderate erosion potential.

High - Factors indicate that the subsoils are likely to erode severely.

Susceptibility to Cutbank Sloughing and Raveling

This rating evaluates each unit for its susceptibility to sloughing or raveling after excavation. Ratings are based on cutbanks at least 10 feet high. Factors include soil and bedrock characteristics, backslope ratio, frost action, climate and potential for revegetation.

Low - Sloughing and/or raveling is a minor problem requiring occasional road maintenance.

Moderate - Sloughing and/or raveling causes some damage. Annual road maintenance is usually adequate.

High - Sloughing and raveling occur at a rate that often plugs culverts and fills inside ditches. Frequent road maintenance with heavy equipment such as front-end loader is required.

Estimated Cutslope Ratio

This interpretation estimates the cutslope ratio which generally will result in the most stable cutbank condition. Ratings made are for cutbanks at least 10 feet high and pertain to both soil and bedrock material. Ratings are based on soil and bedrock factors and on observations.
Cautionary Note: This information is for broad planning purposes only. Specific onsite characterization data is needed to determine the proper ratio.

Steep - Cutbank ratio from vertical to ¼:1

Moderate - Cutbank ratio from about ¼:1 to 1½:1

Flat - Cutbank ratio flatter than 1½:1

Probability of Cutbank Failures [1/]

This interpretation indicates the probability of failures in cutbanks following road or building excavation. The highest rate of failure occurs within the first two years after excavation. On soils rated as having cutbank stability I and II, there will be few failures after the initial two-year period. Soil units rated as having cutbank stability III, IV or V will experience failures after the initial two-year period. Failures can be expected to occur indefinitely on stability V cutbanks.

Failures are considered to be at least 10 cubic yards of material in volume. It should be realized that as the probability of cutbank failures increases, so does the probability that a few of these failures will have volumes in excess of 50 cubic yards and in some instances there will be massive failures where entire sections of the road are lost.

Ratings are based on cutbanks of at least 10 feet in height and refer to more than a 50-percent chance of failure.

1. Very stable - practically no probable chance of cutbank failures.

II. Stable - probability of no more than 3 failures per mile of road cutbank.

III. Moderately stable - probability of 4 to 8 failures per mile of road cutbank.

1/ Applicable to Forest Service class SH, SL, DH and DL roads with cutslope ratios of 1:1 to 3/4:1, and roadbed widths not in excess of 26 feet.

IV. Unstable - probability of 9 to 15 failures per mile of road cutbank.

V. Very unstable - probability of more than 15 failures per mile of road cutbank.

Suggestions for Cutbank Stability Problems

This rating gives suggestions, when applicable, to increase stability of cutbanks or reduce damage from raveling and sloughing.

Failure on Road Waste and Fills

This interpretation rates the soil units as to the susceptibility of failure occurring on fill and sidecast waste material and related damage to resources. Failures are defined as a loss or partial loss of road fill or sidecast material on the fill slope. Considered are initial and subsequent failures caused by construction, erosion and additional sidecast during maintenance. Failures result in damage to various resources. Stream sedimentation levels are increased, resulting in an adverse effect on both water quality and fisheries. Timber growth potential is affected as fill slope areas no longer contribute to production. Occasionally the failures do damage to the road itself. The ratings are based on current road construction practices and procedures and on type of soil materials, natural drainage of the site, landform, slope of the fill, and field observation.

Low - Failure on road waste and fills is sufficiently low to result in only minor damage to resource values.

Moderate - Failures on road waste and fills occur with sufficient frequency to cause moderate damage to resource values.

High - Failures on road waste and fills occur at a rate and magnitude sufficient to cause major damage to resource values.

Erosion on Road Waste and Fills

This interpretation rates the soil units as to the susceptibility of erosion occurring on fill and sidecast waste material and related damage to resources. Erosion is a loss of surface soil from fill or sidecast. This erosion contributes sedimentation to streams. Timber growth potential is affected as fill slope areas no longer contribute to production. The ratings are based on current road construction practices and procedures and on type of soil materials, natural drainage of the site, landform, slope of the fill, and field observation.

Low - Erosion on road waste and fills is sufficiently low to result in only minor damage to resource values.

Moderate - Erosion on road waste and fills occurs with sufficient magnitude to cause moderate damage to resource values.

High - Erosion on road waste and fills occurs at a magnitude sufficient to cause major damage to resource values.

Suitability of Cutbanks to Seeding

This interpretation indicates the probable success of cutbank seeding. Factors considered in making ratings are soil characteristics, elevation, slope, climate, snowpack, and frost hazard. Ratings are based on current methods and practices of seeding, grass species, fertilizer application and time of seeding.

Poor - Probability of success is low. Seeding generally is not successful and requires three or more reseedings and special treatments.

Fair - Success is likely on about 50 percent of area treated. Requires one or two followup treatments. Seeding is usually spotty; some areas become easily established, while others fail completely.

Good - Probability of high success. Seeding usually becomes well established within two years. Little followup seeding necessary.

Limitations to Cutbank Seeding

This indicates the major limitations to success of cutbank seeding.

Suggestions for Cutbank Seeding

This indicates special treatment to be given, when applicable, to increase the chance of success of cutbank seeding.

Suitability of Fillslopes to Seeding

This interpretation indicates the probable success of fillslope seeding. Factors considered in making ratings are soil characteristics, elevation, slope, climate, snowpack, and frost hazard. Ratings are based on current methods and practices of seeding, grass species, fertilizer application and time of seeding.

Poor - Probability of success is low. Seeding generally is not successful and requires three or more reseeding and special treatments.

Fair - Success is likely on about 50 percent of area treated. Requires one or two followup treatments. Seeding is usually spotty; some areas become easily established, while others fail completely.

Good - Probability of high success. Seeding usually becomes well-established within two years. Little followup seeding is necessary.

Limitations to Fillslope Seeding

This indicates the major limitations to success of fillslope seeding.

Suggestions for Fillslope Seeding

This indicates special treatment to be given, when applicable, to increase the chance of of success of fillslope seeding. A statement indicates the necessary requirements other than normal fillslope seeding practices carried on by the Forest.

IV. Unstable - probability of 9 to 15 failures per mile of road cutbank.

V. Very unstable - probability of more than 15 failures per mile of road cutbank.

Suggestions for Cutbank Stability Problems

This rating gives suggestions, when applicable, to increase stability of cutbanks or reduce damage from raveling and sloughing.

Failure on Road Waste and Fills

This interpretation rates the soil units as to the susceptibility of failure occurring on fill and sidecast waste material and related damage to resources. Failures are defined as a loss or partial loss of road fill or sidecast material on the fill slope. Considered are initial and subsequent failures caused by construction, erosion and additional sidecast during maintenance. Failures result in damage to various resources. Stream sedimentation levels are increased, resulting in an adverse effect on both water quality and fisheries. Timber growth potential is affected as fill slope areas no longer contribute to production. Occasionally the failures do damage to the road itself. The ratings are based on current road construction practices and procedures and on type of soil materials, natural drainage of the site, landform, slope of the fill, and field observation.

Low - Failure on road waste and fills is sufficiently low to result in only minor damage to resource values.

Moderate - Failures on road waste and fills occur with sufficient frequency to cause moderate damage to resource values.

High - Failures on road waste and fills occur at a rate and magnitude sufficient to cause major damage to resource values.

Erosion on Road Waste and Fills

This interpretation rates the soil units as to the susceptibility of erosion occurring on fill and sidecast waste material and related damage to resources. Erosion is a loss of surface soil from fill or sidecast. This erosion contributes sedimentation to streams. Timber growth potential is affected as fill slope areas no longer contribute to production. The ratings are based on current road construction practices and procedures and on type of soil materials, natural drainage of the site, landform, slope of the fill, and field observation.

Low - Erosion on road waste and fills is sufficiently low to result in only minor damage to resource values.

Moderate - Erosion on road waste and fills occurs with sufficient magnitude to cause moderate damage to resource values.

High - Erosion on road waste and fills occurs at a magnitude sufficient to cause major damage to resource values.

Suitability of Cutbanks to Seeding

This interpretation indicates the probable success of cutbank seeding. Factors considered in making ratings are soil characteristics, elevation, slope, climate, snowpack, and frost hazard. Ratings are based on current methods and practices of seeding, grass species, fertilizer application and time of seeding.

Poor - Probability of success is low. Seeding generally is not successful and requires three or more reseedings and special treatments.

Fair - Success is likely on about 50 percent of area treated. Requires one or two followup treatments. Seeding is usually spotty; some areas become easily established, while others fail completely.

Good - Probability of high success. Seeding usually becomes well established within two years. Little followup seeding necessary.

Limitations to Cutbank Seeding

This indicates the major limitations to success of cutbank seeding.

Suggestions for Cutbank Seeding

This indicates special treatment to be given, when applicable, to increase the chance of success of cutbank seeding.

Suitability of Fillslopes to Seeding

This interpretation indicates the probable success of fillslope seeding. Factors considered in making ratings are soil characteristics, elevation, slope, climate, snowpack, and frost hazard. Ratings are based on current methods and practices of seeding, grass species, fertilizer application and time of seeding.

Poor - Probability of success is low. Seeding generally is not successful and requires three or more reseeding and special treatments.

Fair - Success is likely on about 50 percent of area treated. Requires one or two followup treatments. Seeding is usually spotty; some areas become easily established, while others fail completely.

Good - Probability of high success. Seeding usually becomes well-established within two years. Little followup seeding is necessary.

Limitations to Fillslope Seeding

This indicates the major limitations to success of fillslope seeding.

Suggestions for Fillslope Seeding

This indicates special treatment to be given, when applicable, to increase the chance of of success of fillslope seeding. A statement indicates the necessary requirements other than normal fillslope seeding practices carried on by the Forest.

RECREATION

Interpretations for recreation pertain primarily to recreation development. They are based on soil and bedrock properties, drainage, landform and vegetation. Factors such as aesthetics and accessibility are not considered when making these ratings. The following interpretations are some most generally needed for planning recreation developments.

Soil Suitability for Recreation Area Development

This rating is based on soil and bedrock characteristics and topographic features of each unit as related to recreation development. Factors important to this interpretation are soil depth, texture, structure, permeability, drainage, topography, and susceptibility to flooding.

Unsuited- This rating indicates that soils and/or topography are of a nature which would prohibit recreation development without extensive modification.

Low - These soil units have major limitations to recreation development but limited development is feasible.

Moderate - This rating indicates that the soil unit is generally suitable for recreation development but has minor limitations.

High - These soils are particularly well suited for recreation development. Generally, they have no limitations.

Soil Limitations for Recreation Development

This indicates the major limitations to recreation development.

Suggested Treatment to Increase Suitability

This indicates, when applicable, suggested treatment to increase the suitability for recreation development.

Soil and Site Damage Susceptibility

This interpretation applies to recreatior areas after development. Each soil that is suitable or can be made suitable for campground development, is rated for its susceptibility to damage of soil and/or site by normal recreation use. Site includes vegetation as well as soil conditions. Factors used in determining ratings include surface erosion potential, soil compactibility, and vegetative growth potential.

Low - These soils resist compaction and have a low surface erosion potential. The native vegetation is hardy and will generally come back annually after heavy use. These soils and the vegetation they support will withstand and hold up well under continual use.

Moderate - These soils are not readily compacted and surface erosion potential is moderate to low. The vegetative types are somewhat hardy. In general, these soils and the site can sustain frequent use but require some rehabilitation.

High - These may be either soils that are fragile and support vegetation that is not hardy or soils that are easily compacted. A period of nonuse and major rehabilitation will be required.

Susceptibility to Dustiness

This interpretation pertains only to the soils suitable for recreation development, and applies primarily to unsurfaced roads within recreation areas.

Low - Factors indicate dust will not be a problem.

Moderate - Under normal conditions dust will not be a problem, but under heavy use and droughty conditions, dust very likely will be a problem.

High - Factors indicate dust will be a problem. Dust abatement measures are necessary under normal conditions and use.

Susceptibility to Muddiness

This interpretation pertains only to the soils suitable, or those that can be made suitable, for recreation development. This interpretation rates each soil as to its susceptibility to becoming muddy. The rating is limited to the surface soil under normal conditions. Factors include soil characteristics, climate and drainage.

Low - Muddiness is not likely to be a problem. Factors indicate soils are not susceptible to muddiness.

Moderate - Soils become muddy at times for short periods, occasionally causing problems. Road rock is usually necessary.

High - Soils are very likely to become muddy and remain muddy for long periods. Road rock is necessary. Camp closure may be necessary during wet periods.

Trail Suitability

This interpretation indicates the suitability of each soil for trails. Factors include soil and bedrock characteristics, drainage, climate and slope.

Poor - These soils have properties which severely limit their use for trails. Extensive treatment measures are required.

Moderate - These soils have some limitations for trail development. Certain treatment measures may be required.

Well - These soils have no limitations for trail development.

Limitations for Trails

This indicates the limitations to trails.

Consideration for Trail Improvements

This indicates some treatment measures to be considered in improving suitability for trails.

Suitability for Sewage Filter Field

This interpretation evaluates the soil as to its suitability as a sewage filter field. Ratings are based on soil depth, texture, permeability, drainage and slope. Only those soils suitable for recreation development are rated. Onsite investigation is recommended before design or installation of filter system.

Poor - These soils have properties which make them poorly suited as sewage filter fields. Sewage filter disposal in these soils would be ineffective and create major problems.

Moderate - These soils have properties which limit their use as sewage filter fields. They require a large filter area for adequate drainage which limits the capacity of the campground.

Well - These soils are well suited to sewage filter use and offer only minor limitations, if any.

Soil Limitation to Sewage Filter Field Use

This indicates the major limitations to sewage filter field use.

RANGE AND WILDLIFE MANAGEMENT

Range and wildlife management interpretations are presented to enable better rangeland management through utilization of soil information. These interpretations are oriented toward use by domestic livestock, deer and elk.

Limitations for Domestic Livestock and Wildlife Use

This interpretation indicates the major topographic and site limitations existing on the mapping unit that would hinder use by domestic livestock and wildlife. Forage or the potential for establishing good forage is not considered in this interpretation.

Susceptibility to Compaction

This interpretation indicates the soil's inherent ability to resist compaction by hoofed animals. Factors important to this interpretation are: soil texture, structure, bulk density, pore size and distribution, and rate of infiltration.

Low - Factors indicate that the soil will resist compaction.

Moderate - Factors indicate that the soil has tendencies to become compacted under livestock and wildlife use. Time of grazing on these soil units is important.

High - Factors indicate that soil compaction will be severe unless livestock use is withheld until the soils have adequately dried.

Susceptibility to Soil Displacement

This interpretation indicates the general susceptibility of the soil unit to be displaced by livestock grazing. Soil displacement is the downslope movement of soil. Animal trampling causes loosening of soil particles which are moved downslope by gravity, wind and water. Displacement ratings are based on such facts as texture, slope and field observations.

Low - Factors indicate that displacement is insignificant. Slopes usually are less than 35 percent.

Moderate - Factors indicate that moderate soil displacement will occur.

High - Factors indicate that displacement is severe and slopes usually exceed 50 percent.

Potential for Range Improvement Through Seeding

This interpretation indicates the potential for each mapping unit to be improved through seeding. Factors used to determine the potential for range improvement through seeding are climate, topography, natural vegetation and the soil characteristics that relate to water-holding capacity and fertility.

Low - This rating indicates the potential for a successful grass seeding is low. Probability of success is very limited.

Moderate - This rating indicates that some problems will be encountered in attaining a satisfactory grass cover.

High - This rating indicates that necessary conditions for a successful grass cover establishment exist.

Limitations to Range Seeding

This interpretation indicates the major limitations to successful range improvement through seeding. Limitations are based on field observations, topography, climate, and soil characteristics.

APPENDIX VI

TERMS AND DEFINITIONS OF MAPPING UNIT CRITERIA 1/

Following is a list of terms and definitions used in Soil Resource Inventories. These terms and definitions are used in compiling information for the Table of Soil Characteristics of Modal Sites; Table of Some Mapping Unit Characteristics, Features and Qualities; Table of Bedrock Characteristics of Mapping Units, and the Mapping Unit Descriptions.

1/ Unless otherwise noted, the following definitions were developed for use in Soil Resource Inventories, R-6.

SOIL CHARACTERISTICS

These terms are found in the Table of Soil Characteristics of Modal Sites. They describe morphological properties of the soil.

Soil - Any and all loose, unconsolidated, weathered material on the earth's surface resting on solid, consolidated, unweathered bedrock, regardless of origin, mode of formation, or type of weathering or deposition. Generally includes any material that may be manipulated by hand tools or heavy equipment without the need of blasting except soft unweathered bedrock. In soil horizon designation, soil materials included A, B and C horizons.

Depth of Soil to Bedrock - Distance from soil surface to consolidated, unweathered bedrock. Depth is in feet.

Shallow - less than 3 feet.

Moderately deep - 3 to 6 feet.

Deep - 6 to 12 feet.

Very deep - greater than 12 feet.

Depth to Restrictive Layer in the Soil - Distance from soil surface to a layer in the soil that is highly restrictive to drainage, water transmission or root growth. Usually this is a discontinuity or stratification layer, but it may be bedrock. If it is bedrock, depth must be the same as recorded under depth to bedrock. A restrictive layer is generally not a genetic soil horizon except in old soils that have developed claypan, hardpan, or cemented horizons. Depth is in feet.

Litter - Total depth in inches of decomposed and undecomposed organic matter.

Soil Layer - Each soil layer is a homogeneous layer of soil material. Soil layers are described when soil characteristics change significantly and have definite effects on management. Layers are usually at least 12 inches thick, unless material is very contrasting. Each layer may result from stratification or soil formation processes.

Soil Layer Thickness - Thickness of each soil layer in inches.

Soil Layer Thickness Classes - Thickness is in feet.

Thin - Less than 3 feet

Moderately thick - 3 to 6 feet

Thick - 6 to 10 feet

Very thick - greater than 10 feet

Color - Stated in narrative Munsel notations for each soil layer. Colors are taken of moist crushed soil. Mottling is noted, if present, especially in subsoil layers.

Texture - Relative proportions of sand (2.0 mm.-.05 mm.), silt (.05 mm.-.02 mm.), and clay (less than .002 mm.). Standard USDA textural classes are used for each soil layer.

Textural Classes*- These classes apply when general textural terms are used for the profile sketch in the mapping unit descriptions.

Coarse-textured soils - Sands, loamy sands

Moderately coarse-textured soils - Sandy loam, fine sandy loam

Medium-textured soils - Very fine sandy loam, loam, silt loam, silt

Moderately fine-textured soils - Clay loam, sandy clay loam, silty clay loam

Fine-textured soils - Sandy clay, silty clay, clay

Rock Fragment Quantity, Size, and Shape* Percent by volume occupied by consolidated fragments larger than sand size (larger 2 mm.)

Size Classes - gravel, 2 mm. - 3 inches; cobbles, 3 inches to 10 inches; stones, greater than 10 inches.

Shape Classes - round, thin, flat, subangular, subround, angular, blocky, etc.

Rock Fragment Classes - Used as an adjective to textural classes. Includes gravel, cobble and stone sizes.

0 - 35% - not noted
35 - 50% - gravelly, cobbly or stony
50 - 80% - very gravelly, very cobbly or very stony
80%+ - extremely gravelly, extremely cobbly or extremely stony

Soil Structure*- Includes grade, size and type of structure for each soil layer. If no structure exists, then the soil is massive or single-grained. Concretions or shot are recorded, if present. Applies to aggregate structural units (aggregates and peds).

Grade - Degree of aggregation and expression of the differential between cohesion within aggregates and adhesion between aggregates.

Weak - Indistinct peds, barely observable in place.

Moderate - Distinct peds, moderately durable and evident

Strong - Distinct peds in place, durable

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* Standard USDA Handbook 18 Definitions.

Size - Refers to size of aggregates according to five size classes:

Very fine - less than 5 mm.

Fine - 5 mm. to 10 mm.

Medium - 10 mm. to 20 mm.

Coarse - 20 mm. to 50 mm.

Very coarse - greater than 50 mm.

Type - Refers to relative shape of individual aggregates. There are four primary basic shapes:

Platy - Soil particles arranged around a plane, generally horizontal:

Prism-like - Soil particles arranged around a vertical line and bounded by relatively flat surface (prismatic, columnar).

Block-like - Soil particles arranged around a point and bounded by flat or rounded surfaces (angular blocky, subangular blocky).

Spheroidal - Soil particles arranged around a point and bounded by curved or very irregular surfaces (granular, crumb).

Structureless - No observable aggregation or no definite orderly arrangement of natural lines of weakness.

Massive - The soil material is coherent.

Single-grain - The soil material is incoherent.

Cementation* - includes degree of cementation and the agent of cementation (Ca, Fe, Al, Si). Cementation is generally caused by a chemical process.

Degree of Cementation:

Weak - Soil aggregates can be easily broken by hand, and usually nonrestrictive to water and roots. Example: fragipan.

Strong - Soil aggregates are difficult to break by hand or hand tools and resist movement and penetration of water and roots. Water may be perched or ponded for short periods. Aggregates can be penetrated by hand tools.

Indurated - Soil aggregates are insoluble in water and cannot be broken by hand tools. Aggregates are totally restrictive to water and roots, and usually require ripping or blasting.

Compaction - Relative increase in bulk density which is caused by natural pedogenic processes.

* Standard USDA Handbook 18 Definitions.

Degree of Compaction:

Weak - Soil aggregates are easily broken by hand and are usually nonrestrictive to water and roots.

Moderate - Soil aggregates are difficult to break by hand and resist movement and penetration of water and roots. Water may be perched or ponded for short periods of time.

Strong - Soil aggregates cannot be broken by hand. The soil exhibits nearly total restriction to water and root penetration, and usually requires ripping or blasting.

Permeability - Water or air movement in and through the soil material. The classes are based on soil texture, rock fragment content, porosity and bulk density.

Class:

Very slow - very little, if any, water transmission. Generally fine-textured soils - clay. Less than .05 inch/hr.

Slow - little water transmission. Generally moderately fine-textured soils - clay loams and silty clay loams. .05 inch/hr. to 1 inch/hr.

Moderate - good water transmission. Generally medium-textured soils - loams, silt loams. 1 inch/hr. to 5 inches/hr.

Rapid - water transmission too great for optimum growth. Generally moderately coarse-textured soils, sandy loams, gravelly loams. 5 inches/hr. to 10 inches/hr.

Very rapid - excessive water transmission; soil never becomes saturated. Very porous soils. Generally coarse-textured soils - sands and gravels. Greater than 10 inches/hr.

Consistence* - degree of cohesion and adhesion as indicated by the resistance of the soil aggregate to deformation or rupture under various moisture conditions.

Dry:

Loose - noncoherent.

Soft - easily crushes to powder or single grain.

Slightly hard - easily broken between thumb and forefinger.

Hard - can be broken in the hands without difficulty but difficult to break between thumb and forefinger.

Very hard - can be broken in hands without difficulty.

Extremely hard - cannot be broken in hands.

* Standard USDA Handbook 18 Definitions.

Moist:

Loose - noncoherent.

Very friable - crushes under gentle pressure.

Friable - crushes easily under gentle to moderate pressure between thumb and forefinger.

Firm - crushes under moderate pressure between thumb and forefinger.

Very firm - crushes under strong pressure, barely crushable between thumb and forefinger.

Extremely firm - crushes under very strong pressure, cannot be crushed between thumb and forefinger.

Wet:

Stickiness - is measured by pressing wet soil between fingers.

Nonsticky - practically no adherence when pressure is released.

Slightly sticky - after pressure, soil adheres to both thumb and finger but comes off one rather cleanly. Does not stretch appreciably.

Sticky - after pressure, soil adheres to both thumb and finger and tends to stretch somewhat before pulling apart from either digit.

Very sticky - after pressure, soil adheres strongly to both digits and is markedly stretched when they are separated.

Plasticity - is measured by rolling wet soil and observing wire.

Nonplastic - no wire is formable.

Slightly plastic - wire forms, but soil mass easily deformed.

Plastic - wire forms, moderate pressure required to deform soil mass.

Very plastic - wire forms, much pressure required to deform soil mass.

Soil pH [1/] - intensity of soil acidity or alkalinity expressed on a scale from 1 to 14:

	pH		pH
Extremely acid	- below 4.5	Slightly alkaline	7.4 - 8.4
Strongly acid	- 4.6 - 5.5	Strongly alkaline	8.5 - 9.0
Slightly acid	- 5.6 - 6.4	Very strongly alkaline	Above 9.0

Classification - estimated Soil Taxonomy classification at family level.

1/ All pH values were taken by the Hellige-Truog or Oregon State University test methods.

MAPPING UNIT CHARACTERISTICS, FEATURES AND QUALITIES

These terms are found in the Table of Some Mapping Unit Characteristics, Features and Qualities. They describe properties of the mapping unit that result from soil characteristics, bedrock characteristics, topography and site.

Infiltration Rate - Rate of entry of water into soil surface. The rate is dependent upon the type of surface soil texture, rock fragment content, structure, porosity, bulk density and organic matter content.

Infiltration Rate Classes

Slow - Water stands on surface for long periods. Soils are fine-textured, poorly aggregated and puddle easily.

Moderate - Water enters soil at commensurated rates of normal rainfall or water application. Water may pond for short periods (a few days) following very intensive rainfall. Soils are medium textured and well aggregated.

Rapid - Water rarely ponds, enters soil surface very rapidly. Soils are coarse-textured, porous, loose and usually single-grained.

Drainage Class [2/] - The rapidity and extent of removal of water from the soil, based on soil permeability, infiltration, internal drainage and topographic position:

Poorly drained - Water table at or near the surface a considerable part of the time. Soils of this class usually occupy level or depressed sites and are frequently ponded. Water is removed so slowly that soil remains wet almost all the time.

Imperfectly drained - Water removed so slowly that the soil remains wet for significant periods, but not all the time.

Moderately well drained - Soil remains wet for a period somewhat longer (up to one month) than the wet season, may be due in part to a slowly permeable layer, high water table or lateral seepage.

Well drained - Water is removed from soil readily and these soils are saturated only during the wet season for short periods.

Excessively drained - Water is removed from soil rapidly and these soils are rarely ever saturated. Commonly, these soils are coarse-textured or shallow, stony and/or occur on steep slopes.

2/ Very poorly drained and somewhat excessively drained classes are not used.

Surface Drainage Intensity and Pattern - Number of drainage miles per square mile and dominant drainage pattern.

Intensity Classes:

Few - 0 to 1 drainage miles per square mile.

Common - 1 to 3 drainage miles per square mile.

Many - 3 to 5 drainage miles per square mile.

Abundant - Greater than 5 drainage miles per square mile.

Patterns:

Dendritic - Drainages branch in random directions.

Parallel - Drainages are relatively parallel.

Productivity - Combined evaluation of measured and observed production of timber and forage types. Site classes are to be used for timber types and range condition ratings for range types.

Site Class - Class limits correspond to height (site index) of Douglas-fir at 100 years.

Class I - greater than 185 S.I.

Class II - 185 S.I. to 155 S.I.

Class III - 155 S.I. to 125 S.I.

Class IV - 125 S.I. to 95 S.I.

Class V - less than 95 S.I.

Fertility - Estimated inherent soil fertility and availability of plant nutrients. This rating is derived by correlating measured productivity with soil factors such as texture, pH, color and organic matter content.

High - These soils generally have medium to fine texture, dark surface colors; are slightly acid to slightly alkaline and have abundant incorporated organic matter. Nutrient quantities are adequate and readily available. Productivity is high as evidenced by timber site classes of I and II.

Moderate - These soils generally have one or more soil factors that limit nutrient quantity and/or availability. Productivity is moderate as evidenced by timber-site classes of low II to high IV.

Low - These soils generally have several factors that are limiting. They may be coarse-textured, strongly acid or strongly alkaline, and lacking in sufficient organic matter. Nutrient quantity and/or availability is seriously limiting. Productivity is low as evidenced by timber-site classes IV and V.

Percent Vegetative Cover - Evaluation of total vegetative cover and the cover of three distinct levels of vegetation above the soil surface. Overstory consists of the timber stand canopy. Understory consists of woody shrubs, and timber regeneration. Ground cover consists of ferns, grasses, sedges, and mosses.

Total Ground Cover - Estimated percent of total vegetative cover with overstory, understory, and ground cover combined. Maximum of 100 percent.

Vegetative Cover by Each Level - Estimated percent vegetative cover according to species composition, with overstory, understory, and ground cover estimated separately. Maximum of 100 percent for each level.

Root Distribution*- Includes root size, abundance and depth to zone of rooting:

Size:

Very fine - 0.075 mm.

Fine - 1 to 2 mm.

Medium - 2 to 5 mm.

Coarse - Over 5 mm.

Abundance:

Very few - less than 1/unit [3/]

Few - 1 to 3/unit

Plentiful - 4 to 14/unit

Abundant - More than 14

Depth:

Recorded depth in inches of zone of rooting. Distance is measured from soil surface to depth of majority of roots.

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* Standard USDA Handbook 18 Definitions.

3/ Unit is a square inch for fine to very fine; a square yard for medium and coarse roots.

Landform - Refers to the shape and configuration of a specific, identifiable part of the landscape common to the mapping unit.

Slope - Range of slope of mapping unit.

Aspect - Direction of slope exposure.

Elevation - Altitude above mean sea level expressed in feet.

BEDROCK CHARACTERISTICS

These terms are found in the Table of Bedrock Characteristics of Mapping Units.

Bedrock - Consolidated, competent rock which upon weathering produces loose or unconsolidated soil material. In terminology of soil horizon designation, bedrock is designated at the "R" layer. Bedrock material usually requires ripping and/or blasting. Includes soft materials that are unweathered such as some sedimentary rock which can be bladed. (Example: Sandstone).

Composition - Bedrock components and percentage. (Example: Sandstone (20), Conglomerates (70), Mudstone (10).

Color - Color is in narrative terms for fresh unweathered surfaces.

Hardness - Relative rating based on ease of breaking rock with a geology hammer.

Hard - Rock cannot be broken or only with great difficulty.

Moderately hard - Rock can readily be broken with hammer but not by hand.

Soft - Rock can be broken by hand.

Degree of Fracturing - Based on the number or frequency of fractures and joints in a rock unit.

Highly fractured - Entire rock unit is completely dissected by fractures and joints less than 1 foot apart.

Moderately fractured - Fractures divide rock unit into units or blocks generally from 1 to 5 feet apart.

Slightly fractured - Only occasional fractures noted.

Massive - No fractures or very few fractures noted.

Fracture System - Pattern which the rock fractures follow. Example: horizontal, platy, vertical, blocky, random, etc.

Fracture Surface - Indicates the characteristics of the fracture surface and void space within fractures.

Regular - Smooth, distinct, sharp, clean-fractured surfaces.

Irregular - Rough, irregular, fragmented fracture surfaces.

Competency - Relative inherent strength of rock as it occurs on the landscape, based on degree of weathering, fracturing, hardness, stability and failures observed.

Competent - No failures within rock unit observed. Rocks of unit are stable and have strong resistance to mass movement.

Moderately competent - Some failures are noted. Rocks of the unit are moderately stable and have some resistance to mass movement.

Incompetent - Failures are common to rock unit. Rocks of the unit are soft, deeply weathered and have high potential for mass movement.

APPENDIX VII

ENGINEERING LABORATORY TEST DATA

This appendix contains standard test data for some representative soils. The mechanical analysis was done by the laboratory at the North Bend Ranger District.

Report of Laboratory Test Results

Soil No. 32

Location: NE¼SW¼, Sec. 12, T. 18 N., R. 12 E., W.M.	Mechanical Analysis	
Depth: 6-24" Unified: SM-d ASSHO:	Sieve Size	% Passing
Liquid Limit: Plasticity Index: N.P.	3	100
pH (by Photovolt pH meter):	1½	79.7
Minimum Electrical Resistivity, Ohms per cc:	3/4	68.9
Hydrometer Analysis:	3/8	58.7
	No. 4	52.5
	10	48.1
	40	38.7
	80	25.4
	200	17.3

Soil No. 37

Location: SW¼NE¼, Sec. 6, T. 17 N., R. 15 E., W.M.	Mechanical Analysis	
Depth: 3-5' Unified: GP-GM ASSHO:	Sieve Size	% Passing
Liquid Limit: 52 Plasticity Index: 19	3	100
pH (by Photovolt pH meter):	1½	99.3
Minimum Electrical Resistivity, Ohms per cc:	3/4	89.8
Hydrometer Analysis:	3/8	69.6
	No. 4	45.7
	10	23.0
	40	18.4
	80	13.9
	200	9.4

Soil No. 42

Location: NW¼NE¼, Sec. 15, T. 16 N., R. 15 E., W.M.	Mechanical Analysis	
Depth: 3-4 feet Unified: SM-u ASSHO:	Sieve Size	% Passing
Liquid Limit: 57 Plasticity Index: 22	3	100
pH (by Photovolt pH meter):	1½	99.6
Minimum Electrical Resistivity, Ohms per cc:	3/4	94.0
Hydrometer Analysis:	3/8	86.0
	No. 4	77.0
	10	46.0
	40	38.0
	80	31.0
	200	27.0

Report of Laboratory Test Results

Soil No. 62

Location: NW¼NW¼, Sec. 10, T. 17 N., R. 14 E., W.M.	Mechanical Analysis	
Depth: 1-3 feet Unified: SM-u ASSHO:	Sieve Size	% Passing
Liquid Limit: 59 Plasticity Index: 14	3	100
pH (by Photovolt pH meter):	1½	93.0
Minimum Electrical Resistivity, Ohms per cc:	3/4	86.4
Hydrometer Analysis:	3/8	82.0
	No. 4	77.5
	10	60.7
	40	46.6
	80	34.5
	200	23.0

Soil No. 75

Location: NE¼NE¼, Sec. 29, T. 18 N., R. 14 E., W.M.	Mechanical Analysis	
Depth: 7-8 feet Unified: S.C. ASSHO:	Sieve Size	% Passing
Liquid Limit: 36 Plasticity Index: 14	3	100
pH (by Photovolt pH meter):	1½	99.6
Minimum Electrical Resistivity, Ohms per cc:	3/4	99.3
Hydrometer Analysis:	3/8	98.1
	No. 4	96.0
	10	88.8
	40	70.3
	80	55.7
	200	45.2

Soil No. 76

Location: SW¼NE¼, Sec. 29, T. 18 N., R. 14 E., W.M.	Mechanical Analysis	
Depth: 6-18" Unified: SM-d ASSHO:	Sieve Size	% Passing
Liquid Limit: Plasticity Index: N.P.	3	100
pH (by Photovolt pH meter):	1½	95.2
Minimum Electrical Resistivity, Ohms per cc:	3/4	91.8
Hydrometer Analysis:	3/8	84.9
	No. 4	73.8
	10	60.8
	40	47.4
	80	33.0
	200	25.1

APPENDIX VIII

GLOSSARY

Alluvium - Fine material, such as sand, silt, or clay that has been deposited on land by streams.

Andesite - A dark gray to black, dense, fine-grained extrusive igneous rock. Very similar to basalt.

Argillite - An extremely hard, fine-grained, gray to black sedimentary rock composed primarily of clay minerals. It is distinguished from shale and slate by its lack of cleavage planes parallel to stratification. It typically breaks up into small pencil-like fragments.

Arkosic Sandstone - Sandstone that is low in quartz and high in clay-bearing minerals.

Ash - Sand-size volcanic ejecta as used in this report.

Basalt - A dark gray to black, dense, fine-grained extrusive igneous rock. Very similar to andesite.

Basaltic Breccia - A highly-fractured marine basalt with inclusions of angular fragments of other previously formed rocks.

Base Flow - Sustained or fair weather runoff. It is composed of groundwater runoff and delayed subsurface runoff.

Bedrock - The rock that underlies the soil and other unconsolidated material, or that is exposed at the surface.

Block Glide - A deep-seated, slow-moving failure marked by lateral separation with but little vertical displacement. Generally occurs in plastic materials.

Clay - A soil separate less than .002 millimeters in diameter. As a soil textural class, less than 45 percent sand, and less than 40 percent silt.

Colluvium - Soil material or rock fragments moved downslope by gravitational force in the form of soil creep, slides, and local wash.

Compaction - The packing together of soil particles by forces exerted at the soil surface resulting in increased soil density.

Complex - An association in which two soil units or a soil unit and a miscellaneous landtype are so intricately mixed that it is not practical to show them separately at the scale of mapping used.

Conglomerate - A highly-resistant sedimentary rock, consisting of firmly-cemented sand and gravel.

Critical Soil - The term "critical soil" is frequently used by laymen, but it is a meaningless term unless it is related to a specific function. Many soils may be critical for one reason or another but different soils may not be critical for the same reasons. For example, a deep, wet, plastic and unstable soil will be critical in relation to road location and stability. This soil is not critical in relation to regeneration and droughtiness problems. Another soil may be very shallow over hard bedrock. This soil is not critical from the standpoint of road stability, but may be critical as to regeneration problems resulting from droughtiness and low fertility. It may also be critical in relation to surface erosion. From these two examples, it becomes obvious that the term "critical soil" must be defined by the user in relation to its intended purpose.

Debris Slide - A rapidly moving slide composed of soil, bedrock or both.

Erosion - The wearing away of the land surface by running water, wind, ice or gravitational creep. Accelerated erosion may result from the activities of man or animals.

Extrusive Bedrock - This applies to those igneous rocks derived from volcanic lavas that cooled on the surface of the earth. This lava cools rapidly and forms fine-textured rocks such as basalt and andesite.

Feldspathic Sandstones - Sandstone that is high in quartz and low in clay-producing minerals.

Geomorphology - The study of landforms as they relate to geologic composition and history.

Glacial Drift - The debris deposited by glaciers or by streams directly associated with them.

Glaciofluvial Depsoits - Soil materials that have been transported and deposited by glaciers and subsequently reworked by water.

Glaciolacustrine Deposits - Soil materials transported by glaciers and deposited by glacial meltwater in glacial lakes, ranging from fine sand and small gravel near the lakeshores, to fine silts and clay in the lake bottom.

Glacial Soils - Soils derived from materials transported or influenced by glaciers.

Glaciated Valley - U-shaped valley formerly occupied by a glacier.

Graywacke - A loose and general term for sandstone containing significant quantities of clay materials.

Hummocky - Hilly, uneven landscape resulting from deep-seated soil movement, usually of a rotational nature.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Intrusive Bedrock - This applies to those rocks derived from magmas that have been injected into older rocks at depth without reaching the surface. These magmas are slow-cooling and form coarse-textured rocks, such as granite.

Landform - Structural configuration of the topography as a result of past and present geological activity.

Mapping Unit - Any delineated area shown on a soil map that is identified by a number. A mapping unit may be a soil unit, a miscellaneous landtype, or a complex.

Massive - Soil structure or bedrock condition in which there is no observable aggregation or no definite orderly arrangement of natural lines of weakness.

Mass Movement - All movement of soil and bedrock materials occurring below the soil surface such as landslips, landflows, rock slides, slumps, etc.

Mass Wasting - Wearing away of the landscape through the process of mass movement. Geologic erosion.

Miscellaneous Landtype - A mapping unit for areas of land that have little or no natural soil, or have properties that are too variable and unpredictable for classification.

Mudstone - Soft, fine-grained, gray to black sedimentary rock composed primarily of clay minerals. It lacks cleavage planes parallel to stratification and typically breaks into small block-like fragments.

Outwash - Glacial material swept out, sorted and deposited by water that originated from the melting of glacial ice.

Peak Flow (Peak Runoff) - The greatest water discharge for any single runoff period.

Plastic Soil - A soil capable of being molded or deformed continuously and permanently, by relatively moderate pressure, into various shapes.

Pumice - An excessively cellular, light-colored, volcanic ejecta.

Pyroclastic - A general term applied to rocks formed from volcanic material that has been explosively or aerially ejected from a volcanic vent.

Residuum - Soil material formed by rock weathering in place.

Runoff - That part of the precipitation which appears in surface streams of either perennial or intermittent form.

Sand - A soil separate between .05 and 2.0 mm. in diameter.

Sandstone - A hard rock composed primarily of cemented sand-size grains.

Sedimentary Rock - Rock formed by deposition of soil and rock particles by water, ice or wind that later solidifies through cementation, ionic exchange or compression.

Shale - Fine-grained rock, softer than slate, consisting of clay minerals and silt, which characteristically splits readily along closely-spaced planes, parallel to stratification.

Sheet Erosion - Uniform removal of surface soil by water flowing overland or by wind.

Silt - A soil separate consisting of particles between 0.002 and 0.05 millimeters in diameter.

Siltstone - A sedimentary rock consisting primarily of silt-size particles.

Slate - Rock formed by the metamorphism of shale. Slate is very fine-grained and exceptionally well-foliated. Because of its excellent foliation, it splits into thin sheets parallel to stratification.

Slump - A deep-seated, slow-moving, rotational failure occurring in plastic materials, resulting in vertical and lateral displacement.

Soil - Any and all loose, incoherent, unconsolidated weathered material on the earth's surface resting on consolidated, weathered or unweathered bedrock, no matter how formed, or origin, or method of weathering or deposition. Generally includes any material that may be moved or broken by hand tools or heavy equipment without the need of blasting except soft, unweathered bedrock. In soil horizon designation, soil materials included A, B, and C horizons.

Soil Creep - Slow mass movement of soil material downslope primarily under the influence of gravity, but facilitated by saturation with water and/or by alternating freezing and thawing.

Soil Unit - Taxonomic description of a portion of the landscape sufficiently uniform in soil, bedrock and landform so that it can be clearly defined and easily recognized wherever it occurs.

Spot Symbols - Symbols used on soil maps to represent a landscape factor too small to delineate.

Surface Slips - Rapid movement downslope of the surface few feet of soil on steep slopes.

Till - Glacial materials deposited directly by ice with little or no transportation by water. It is generally an unconsolidated, unstratified compact mixture of clay, silt, sand, gravel and boulders.

Toeslope - Portions of a slope that is transitioned between the valley floor and the upper slope.

Topography - The relief features or surface configuration of an area.

U-shaped Valley - Descriptive phrase of the cross-profile of a valley which has been carved out by glacial movement.

V-shaped Valley - A descriptive phrase of the cross-profile of a valley which has been cut by stream action.