United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Washington State
Department of Natural
Resources; United States
Department of
Agriculture, Forest
Service; and Washington
State University
Agricultural Research
Center

Soil Survey of Snoqualmie Pass Area, Parts of King and Pierce Counties, Washington

How To Use This Soil Survey

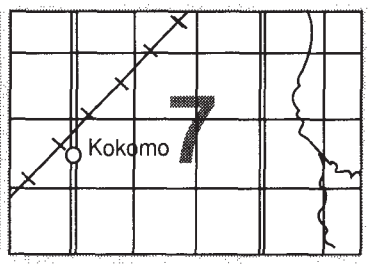
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

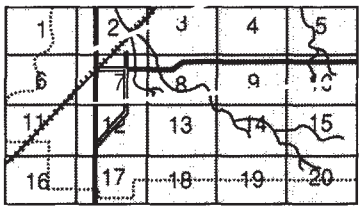
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



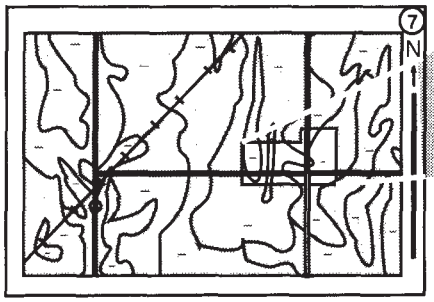
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

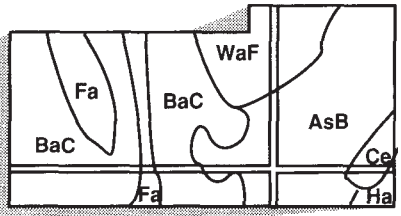


INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in July 1980. Soil names and descriptions were approved in April 1986. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980. This survey was made cooperatively by the Soil Conservation Service; the Washington State Department of Natural Resources; United States Department of Agriculture, Forest Service; and Washington State University Agricultural Research Center. It is part of the technical assistance furnished to the conservation districts of King and Pierce Counties.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: A wooded area in the valley of the South Fork of the Snoqualmie River.

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Family or higher taxonomic class.

Foreword

This soil survey contains information that can be used in land-planning programs in the survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of Snoqualmie Pass Area, Parts of King and Pierce Counties, Washington

By Alan Goldin, Soil Conservation Service

Fieldwork by James A. Mitchell, Steven B. Campbell, and Charles S. Natushara, Soil Conservation Service, and John A. Fisher and Carla Culver, Washington State Department of Natural Resources

Woodland fieldwork by William J. Westberg, forestry consultant

United States Department of Agriculture, Soil Conservation Service, in cooperation with Washington State Department of Natural Resources; United States Department of Agriculture, Forest Service; and Washington State University Agricultural Research Center

The survey area is in the west-central part of Washington (fig. 1). It is bounded by Snohomish County on the north, Lewis County on the south, and Mount Rainier National Park on the southeast. It makes up the eastern part of King and Pierce Counties. It has a total area of 1,187,130 acres, or about 1,855 square miles.

Two older surveys, "Soil Survey of King County Area, Washington" and "Soil Survey of Pierce County Area, Washington," were published in 1973 and 1979, respectively *(26, 36)*. These earlier surveys cover a very small part of the present survey. Four other older surveys have been completed for parts of the survey area: "Soil Resource Inventory—Snoqualmie National Forest," published in 1972 *(27)*; "Soil Survey of the Snoqualmie Falls Tree Farm," published in 1961 *(16)*; "Soil Survey of the White River Tree Farm," published in 1973 *(13)*; and "Soil Survey of the Snoqualmie Falls Tree Farm," published in 1974 *(32)*. The present survey updates these earlier surveys. It provides additional information and has larger maps, which show the soils in greater detail.

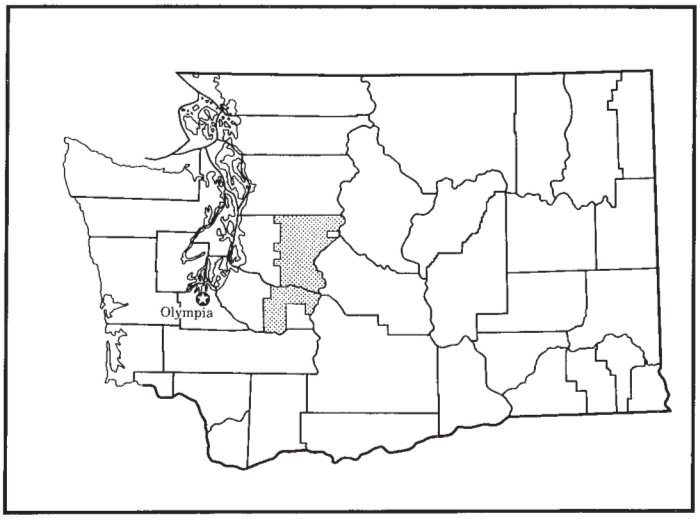

Figure 1.—Location of Snoqualmie Pass area in Washington.

General Nature of the Survey Area

This section gives general information about the survey area. It describes history and development; physiology, relief, and drainage; and climate.

History and Development

The modern history of this survey area begins in the 1830's. At this time explorers from the Hudson's Bay Company traveled through Naches Pass, establishing a link between the forts on the east and west sides of the Cascade Mountains. In 1854, the President and the

Secretary of War authorized railroad surveys, which began an extensive exploration of the Cascades.

Miners probably reached the area as early as the 1860's. For a while they came by the hundreds, but the "rush" was short lived. Mining for coal began in the Carbon River area in 1862, mining for iron ore in the Snoqualmie River Valley near North Bend in 1869, and mining for iron and copper in the Cedar River area in 1891. Mining continues to be a significant industry in the survey area.

Logging started in the valley of the Skykomish River in about 1860, in the valley of the Snoqualmie River in 1872, in the valley of the Green River in 1880, in the valley of the White River in 1896, and along the Carbon River in 1912. As logging progressed and new logging methods were introduced, mills were established throughout the area.

The Federal Government gave railroad companies vast quantities of land to finance construction across the continent. In 1888, the Northern Pacific railroad built a line through the mountains at Stampede Pass. In 1915, the Chicago, Milwaukee, and St. Paul Railroad completed construction of a tunnel through Snoqualmie Pass. Subsequent lines and spurs further opened the Cascades.

Water is a valuable resource in the survey area. In 1898, Seattle acquired the water rights for the Cedar River watershed. In 1910, Tacoma constructed a gravity water-supply system from the Green River watershed.

Recreational sites are an important resource in the survey area. Skiing, hiking, climbing, camping, hunting, fishing, and berry picking are among the numerous recreational activities. The first ski lodge in Snoqualmie Pass was constructed in 1913.

In 1891, Congress passed the General Land Law Revision Act, which included a provision authorizing the President to withdraw forest reserves from the unreserved public domain. This law led to the formation of the Snoqualmie National Forest in 1908. In 1973, Mt. Baker National Forest was merged with Snoqualmie National Forest, forming Mt. Baker-Snoqualmie National Forest *(18)*.

Physiography, Relief, and Drainage

Russell F. Pringle, Soil Conservation Service, assisted in writing this section.

This survey area extends from the crest of the Cascade Mountain Range west to the Puget Sound lowlands. The uplands in the eastern part of the survey area have rugged mountains and alpine topography that were modified by glacial activity and are drained by rivers that generally flow to the west. The landscape is characterized by long, steep slopes and relatively straight, parallel drainageways. The average elevation of the ridgetops ranges from 5,000 to 6,000 feet. Crystal Mountain has the highest elevation, about 7,800 feet.

The survey area has six large drainage systems, including the headwaters of the Cedar, Green, Nisqually, Puyallup, Skykomish, and Snoqualmie Rivers. These rivers have very similar topography. They originate in mountain areas and flow into the Puget Sound lowlands.

The Cedar River originates in the Yakima Pass area of the Cascade Mountain Crest, flows in a northwesterly direction, and empties into Lake Washington near Renton.

The Green River originates in the Cascade Mountains, flows in a northwesterly direction to Chester Morse Lake, and empties into Puget Sound near Seattle. Chester Morse Lake is part of the water supply for Seattle.

The Nisqually River forms part of the southern boundary of the survey area. It originates on the Nisqually glacier, flows in a westerly direction, and empties into Puget Sound between the cities of Olympia and Tacoma. The Nisuqally glacier is on the flanks of Mount Rainier.

The Puyallup River originates on the Puyallup and Tacoma glaciers on the slopes of Mount Rainier. It flows into Puget Sound near Tacoma.

The Skykomish River originates in the Stevens Pass area, flows into Snohomish County, and empties into Puget Sound near Everett.

The Snoqualmie River originates in the Cascade Mountains north of Snoqualmie Pass. It flows in a northwesterly direction and forms part of the western boundary of the survey area. It flows in a northerly direction into Snohomish County, where it merges with the Skykomish River.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

The climate of the Snoqualmie Pass area is greatly tempered by winds from the Pacific Ocean. Summers are fairly warm, but hot days are rare. Winters are cool, but snow and freezing temperatures are common only at the higher elevations. At the lower elevations freezing temperatures commonly occur under the influence of dry air masses. In summer rainfall is extremely light. Irrigation is needed if crops are grown during the summer. Several consecutive weeks without precipitation are common. During the rest of the year, rains are frequent, especially in late fall and winter.

In most winters one or two storms are accompanied

by strong and sometimes damaging winds, and in some years the accompanying heavy rains cause serious flooding. In some years, either during winter or summer, a large invasion of a continental air mass from the east causes abnormal temperatures. As a result, several consecutive days are well below freezing in winter or a week or longer is sweltering in summer.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Baring in the period 1970 to 1978, Electron Headworks in the period 1951 to 1978, and Snoqualmie Pass in the period 1952 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperatures at Baring, Electron Headworks, and Snoqualmie Pass are 36, 35, and 29 degrees F, respectively. The average daily minimum temperature is 31 degrees at Baring, 30 degrees at Electron Headworks, and 24 degrees at Snoqualmie Pass. The lowest temperature on record, which occurred at Snoqualmie Pass on December 39, 1968, is -19 degrees. In summer the average temperature is 61 degrees at Baring, 59 degrees at Electron Headworks, and 56 degrees at Snoqualmie Pass. The average daily maximum temperature is about 70. The highest recorded temperature, which occurred at Electron Headworks on August 17, 1977, is 100 degrees.

Growing degree days, shown in table 1, are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 114 inches at Baring, 64 inches at Electron Headworks, and 105 inches at Snoqualmie Pass. About 25 to 30 percent of the total usually falls in April through September, which includes the growing season for most crops. The heaviest 1-day rainfall during the period of record was 7.38 inches at Baring on February 27, 1972. Thunderstorms occur on about 10 days each year.

The average seasonal snowfall is about 61 inches at Baring, 48 inches at Electron Headworks, and 514 inches at Snoqualmie Pass. The greatest snow depth at any one time during the period of record was 32 inches at Baring, 14 inches at Electron Headworks, and 225 inches at Snoqualmie Pass. On the average, 58 days at Baring, 38 days at Electron Headworks, and 75 days at Snoqualmie Pass have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 60 percent of the time possible in summer and 25 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 13 miles per hour, in spring.

How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind or segment of the landscape. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Individual soils on the landscape commonly merge gradually into one another as their characteristics gradually change. To construct an accurate map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size, and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining

their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

The descriptions, names, and delineations of the soils in this soil survey do not fully agree with those of the soils in adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in series concepts, or variations in the intensity of mapping or in the extent of the soils in the survey areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The soils or miscellaneous areas making up one unit can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils or miscellaneous areas can be identified on the map. Likewise, areas that are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The general map units in this survey have been grouped into general kinds of landscape for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

Map Unit Descriptions

Soils on High Mountains

These soils make up about 44 percent of the survey area. They are nearly level to very steep. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 6,000 feet. The average annual precipitation is 70 to 130 inches, and the average annual air temperature is 37 to 42 degrees F. The average frost-free period is 70 to 130 days.

These soils are moderately deep, deep, and very deep and are excessively drained, moderately well drained, and well drained. They formed in pumice and volcanic ash over residuum and colluvium derived from extrusive igneous rocks, andesite, tuff, breccia, or glacial till and in a mixture of organic material, volcanic ash, and pumice.

These soils are used mainly for woodland, recreational areas, and wildlife habitat.

1. Ethania-Cattcreek

Very deep, well drained, gently sloping to very steep soils on mountain ridge crests and back slopes and in cirque basins

This map unit is in the southeastern part of the survey area, along the west boundary of Mount Rainier National Park. Slopes are 8 to 90 percent. The vegetation is trees and shrubs. Elevation is 2,800 to 5,300 feet. The average annual precipitation is 80 to 115 inches, and the average annual air temperature is 37 to 39 degrees F. The average frost-free period is 90 to 120 days.

This unit makes up about 4 percent of the survey area. It is about 40 percent Ethania soils, 35 percent Cattcreek soils, and 25 percent soils of minor extent.

Ethania soils formed in dacitic pumice and volcanic ash over residuum and colluvium derived from sandstone, andesite, and glacial till. Typically, the surface layer is very cindery loamy sand. The subsoil is very cindery loamy sand, very gravelly loam, and very gravelly sandy loam. The substratum is extremely cobbly loamy sand.

Cattcreek soils formed in dacitic pumice and volcanic ash over residuum and colluvium derived from andesite. Typically, the surface layer is very cindery loamy sand. The subsoil is very cindery loamy sand and very cindery sand. The substratum is very gravelly sandy loam.

Of minor extent in this unit are Cotteral and Vailton soils and Rock outcrop.

This unit is used for woodland, recreational areas, and wildlife habitat. The main limitation in the areas used for woodland is snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

2. Nimue-Haywire-Chinkmin

Moderately deep and very deep, well drained and moderately well drained, nearly level to very steep soils on ridgetops, mountainsides, and mountain back slopes,

in cirque basins and valleys, and on lateral moraines and drift plains

This map unit is in the southern part of the survey area, along the north boundary of Mount Rainier National Park. Slopes are 6 to 90 percent. The vegetation is trees and shrubs. Elevation is 2,500 to 6,000 feet. The average annual precipitation is 70 to 120 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is 70 to 120 days.

This unit makes up about 11 percent of the survey area. It is about 38 percent Nimue soils, 30 percent Haywire soils, 16 percent Chinkmin soils, and 16 percent soils of minor extent.

Nimue soils are on ridgetops and mountainsides. They are very deep and well drained. They formed in a thin mantle of loess and pumice over residuum and colluvium derived from extrusive igneous rocks or from breccia and tuff. Typically, the surface layer is loamy sand. The subsoil is sandy loam and very gravelly loam. The substratum is extremely gravelly silt loam.

Haywire soils are on ridgetops and mountain back slopes. They are moderately deep and well drained. They formed in volcanic ash and pumice over residuum and colluvium derived from extrusive igneous rocks or from tuff and breccia. Typically, the surface layer is sandy loam. The subsoil is loam, gravelly loam, very cobbly loam, and extremely cobbly loam. Andesite is at a depth of 20 to 40 inches.

Chinkmin soils are in cirque basins and valleys or on lateral moraines and drift plains. They are moderately deep to orstein and are moderately well drained. They formed in a thin mantle of volcanic ash or pumice over colluvium derived from dense glacial till. Typically, the surface layer is sandy loam. The subsoil is gravelly and very cobbly loam. The substratum is very gravelly sandy loam. Dense glacial till is at a depth of 20 to 40 inches.

Of minor extent in this unit are Cayuse, Foss, Nagrom, Playco, and Serene soils and Rock outcrop.

This unit is used for woodland, recreational areas, and wildlife habitat. The main limitation in the areas used for woodland is snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

3. Reggad-Altapeak-Index

Deep and very deep, well drained and excessively drained, gently sloping to very steep soils on mountain slopes and back slopes

This map unit is in the northeastern part of the survey area. Slopes are 8 to 90 percent. The vegetation is trees and shrubs. Elevation is 2,200 to 6,000 feet. The average annual precipitation is 75 to 130 inches, and the average annual air temperature is 40 to 42 degrees F. The average frost-free period is 90 to 130 days.

This unit makes up about 8 percent of the survey area. It is about 37 percent Reggad soils, 23 percent Altapeak soils, 20 percent Index soils, and 20 percent soils of minor extent.

Reggad soils are on mountain back slopes. They are very deep and excessively drained. They formed in a mixture of organic material, volcanic ash, and pumice over rock rubble. Typically, the surface layer is very cobbly muck and very cobbly loam. The underlying material is angular rock fragments.

Altapeak soils are on mountain slopes. They are deep and well drained. They formed in volcanic ash and pumice mixed with residuum and colluvium over granitic and metamorphic rocks. Typically, the surface layer is gravelly sandy loam. The subsoil is very gravelly sandy loam. The substratum is extremely cobbly loamy sand and extremely gravelly coarse sand. Weathered granodiorite is at a depth of 40 to 60 inches.

Index soils are on mountain back slopes. They are deep and well drained. They formed in volcanic ash and pumice mixed with colluvium derived from granitic and low-grade metamorphic rocks. Typically, the surface layer is loamy sand. The subsoil is very cobbly and very gravelly loamy sand. The substratum is extremely cobbly sand. Weathered granodiorite is at a depth of 40 to 60 inches.

Of minor extent in this unit are Klapatche, Playco, Reichel, Serene, and Treen soils; Rubble land; and Rock outcrop.

Altapeak and Index soils are used for woodland, recreational areas, and wildlife habitat. Reggad soils are used for wildlife habitat. The main limitation in the areas used for woodland is snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

4. Nimue

Very deep, well drained, gently sloping to very steep soils on ridgetops and mountain back slopes

This map unit is in the southeastern part of the survey area. Slopes are 6 to 90 percent. The vegetation is trees and shrubs. Elevation is 3,400 to 5,000 feet. The average annual precipitation is 70 to 120 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is 110 to 130 days.

This unit makes up about 5 percent of the survey

area. It is about 72 percent Nimue soils and 28 percent soils of minor extent.

Nimue soils formed in a thin mantle of volcanic ash and pumice and in residuum and colluvium derived from extrusive igneous rocks or from breccia and tuff. Typically, the surface layer is loamy sand. The subsoil is sandy loam and very gravelly loam. The substratum is extremely gravelly silt loam.

Of minor extent in this unit are Foss, Haywire, and Playco soils.

This unit is used for woodland, recreational areas, and wildlife habitat. The main limitation in the areas used for woodland is snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

5. Playco-Nagrom

Moderately deep and very deep, well drained, gently sloping to very steep soils on ridge crests and mountain back slopes

This map unit is throughout the survey area. Slopes are 5 to 90 percent. The vegetation is trees and shrubs. Elevation is 2,400 to 3,600 feet. The average annual precipitation is 75 to 100 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is 110 to 130 days.

This unit makes up about 11 percent of the survey area. It is about 43 percent Playco soils, 29 percent Nagrom soils, and 28 percent soils of minor extent.

Playco soils are on mountain back slopes. They are very deep. They formed in volcanic ash and pumice mixed with colluvium derived from andesite, breccia, and tuff. Typically, the surface layer is very gravelly loamy sand. The subsoil is very gravelly loamy sand and extremely gravelly sandy loam. The substratum is extremely gravelly sandy loam.

Nagrom soils are on ridge crests and mountain back slopes. They are moderately deep. They formed in volcanic ash and pumice over residuum and colluvium derived from extrusive igneous rocks or breccia and tuff. Typically, the surface layer is sandy loam. The subsoil is loam and gravelly loam. The substratum is very gravelly loam. Fractured andesite is at a depth of 20 to 40 inches.

Of minor extent in this unit are Andic Cryumbrepts; Gallup, Getchell, Hartnit, Kindy, Nimue, Reichel, and Stahl soils; and Rock outcrop.

This unit is used for woodland, recreational areas, and wildlife habitat. In the areas used for woodland, the main limitation is snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

6. Playco

Very deep, well drained, gently sloping to very steep soils on mountain back slopes

This map unit is in the central part of the survey area. Slopes are 5 to 90 percent. The vegetation is trees and shrubs. Elevation is 2,500 to 3,600 feet. The average annual precipitation is 75 to 90 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is 110 to 130 days.

This unit makes up about 5 percent of the survey area. It is about 80 percent Playco soils and 20 percent soils of minor extent.

Playco soils formed in volcanic ash and pumice mixed with colluvium derived from andesite, breccia, and tuff. Typically, the surface layer is very gravelly loamy sand. The subsoil is very gravelly loamy sand and extremely gravelly sandy loam. The substratum is extremely gravelly sandy loam.

Of minor extent in this unit are Nagrom, Nimue, Reichel, Spukwush, and Stahl soils and Rock outcrop.

This unit is used for woodland, recreational areas, and wildlife habitat. In the areas used for woodland, the main limitation is snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

Soils on Low Mountains

These soils make up about 31 percent of the survey area. They are nearly level to very steep. The native vegetation is mainly conifers and shrubs. Elevation is 1,400 to 2,800 feet. The average annual precipitation is 55 to 140 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is 110 to 180 days.

These soils are moderately deep, deep, and very deep and are moderately well drained and well drained. They formed in volcanic ash and volcanic ash and loess over colluvium, glacial till over glacial drift, dense glacial till, cemented glacial till, and residuum and colluvium derived from igneous rock, tuff and breccia, and metamorphic rocks.

These soils are used mainly for woodland, recreational areas, and wildlife habitat.

7. Zynbar

Deep and very deep, well drained, nearly level to very steep soils on mountain back slopes

This map unit is in the southwestern part of the survey area. Slopes are 0 to 65 percent. The vegetation is trees and shrubs. Elevation is 1,500 to 2,800 feet. The average annual precipitation is 70 to 100 inches,

and the average annual air temperature is about 44 degrees F. The average frost-free period is 140 to 160 days.

This unit makes up about 3 percent of the survey area. It is about 71 percent Zynbar soils and 29 percent soils of minor extent.

Zynbar soils formed in a mixture of volcanic ash, colluvium derived from basic igneous rocks, and glacial till over glacial drift. Typically, the surface layer is loam. The subsoil is gravelly silt loam. The substratum is silt loam.

Of minor extent in this unit are Bellicum, Cinebar, Jonas, Larrupin, Pitcher, and Vailton soils.

This unit is used for woodland, recreational areas, and wildlife habitat. In the areas used for woodland, the main limitation is occasional snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

8. Pitcher-Jonas-Oakes

Deep and very deep, well drained, gently sloping to very steep soils on mountain back slopes and toe slopes

This map unit is in the central and south part of the survey area. Slopes are 6 to 90 percent. The vegetation is trees and shrubs. Elevation is 1,400 to 2,800 feet. The average annual precipitation is 55 to 90 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is 120 to 180 days.

This unit makes up about 8 percent of the survey area. It is about 38 percent Pitcher soils, 24 percent Jonas soils, 15 percent Oakes soils, and 23 percent soils of minor extent.

Pitcher soils are on mountain back slopes. They are very deep. They formed in volcanic ash over colluvium and residuum derived from andesite or breccia and tuff. Typically, the surface layer is sandy loam. The underlying material is very gravelly loam.

Jonas soils are on mountain back slopes. They are deep and very deep. They formed in colluvium and residuum derived from andesite or tuff and breccia. The colluvium and residuum have an admixture of volcanic ash. Typically, the surface layer is gravelly loam. The subsoil also is gravelly loam. The substratum is very gravelly loam. Weathered tuff is at a depth of 40 to 60 inches.

Oakes soils are on mountain back slopes and toe slopes. They are very deep. They formed in a mixture of volcanic ash and colluvium and slope alluvium derived from glacial drift. Typically, the surface layer is gravelly loam. The subsoil is very gravelly loam. The substratum is very gravelly sandy loam.

Of minor extent in this unit are Bellicum, Bromo, Dobbs, Littlejohn, Olomount, Pheeney, and Voight soils and Rock outcrop.

This unit is used for woodland, recreational areas, and wildlife habitat. The main limitation in the areas used for woodland is occasional snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

9. Kaleetan-Melakwa

Moderately deep and very deep, well drained, gently sloping to very steep soils on mountain back slopes and toe slopes

This map unit is in the northern and central part of the survey area. Slopes are 8 to 90 percent. The vegetation is trees and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is 90 to 130 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is 135 to 155 days.

This unit makes up about 7 percent of the survey area. It is about 61 percent Kaleetan soils, 13 percent Melakwa soils, and 26 percent soils of minor extent.

Kaleetan soils are on glacially modified mountain back slopes and toe slopes. They are very deep. They formed in a mixture of volcanic ash and pumice over colluvium derived from andesite, tuff, breccia, and glacial till. Typically, the surface layer is sandy loam. The subsoil is very gravelly and gravelly sandy loam. The substratum is very gravelly and extremely gravelly sandy loam.

Melakwa soils are on glacially modified mountain back slopes and toe slopes. They are moderately deep. They formed in a mixture of volcanic ash and pumice over colluvium derived from andesite or breccia. Typically, the surface layer is sandy loam. The subsoil is very gravelly sandy loam and very gravelly loam. The substratum is extremely gravelly loam. Hard, fractured andesite is at a depth of 20 to 40 inches.

Of minor extent in this unit are Littlejohn, Marblemount, and Philippa soils.

This unit is used for woodland, recreational areas, and wildlife habitat. In the areas used for woodland, the main limitation is occasional snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

10. Teneriffe-Marblemount

Moderately deep to very deep, well drained, gently sloping to very steep soils on mountain back slopes

This map unit is in the northeastern part of the survey area. Slopes are 8 to 90 percent. The vegetation is trees and shrubs. Elevation is 1,600 to 2,800 feet.

The average annual precipitation is 70 to 130 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is 110 to 155 days.

This unit makes up about 3 percent of the survey area. It is about 45 percent Teneriffe soils, 24 percent Marblemount soils, and 31 percent soils of minor extent.

Teneriffe soils are on mountain back slopes. They are deep and very deep. They formed in volcanic ash and pumice over colluvium derived from granitic and low-grade metamorphic rocks. Typically, the surface layer is loamy sand. The subsoil is loamy sand, gravelly loamy sand, and very gravelly loamy sand. The substratum is very gravelly coarse sand.

Marblemount soils are on glacially modified mountain back slopes. They are moderately deep. They formed in a mixture of volcanic ash, glacial till, and colluvium derived from granite and low-grade metamorphic rocks. Typically, the surface layer is gravelly loamy sand. The subsoil is very gravelly and extremely gravelly loamy sand. Fractured granite is at a depth of 20 to 40 inches.

Of minor extent in this unit are Philippa soils and Rock outcrop. Philippa soils formed in volcanic ash, colluvium, and glacial till.

This unit is used for woodland, recreational areas, and wildlife habitat. In the areas used for woodland, the main limitation is occasional snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

11. Elwell-Philippa

Moderately deep, moderately well drained, nearly level to very steep soils on mountain back slopes, on plateaus, in cirques, and on lateral moraines

This map unit is in the central part of the survey area. Slopes are 0 to 65 percent. The vegetation is trees and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is 60 to 140 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is 130 to 170 days.

This unit makes up about 4 percent of the survey area. It is about 49 percent Elwell soils, 25 percent Philippa soils, and 26 percent soils of minor extent.

Elwell soils are on mountain back slopes and plateaus. They formed in glacial till that has an admixture of volcanic ash and loess. Typically, the surface layer is silt loam. The subsoil is silt loam and gravelly silt loam. Glacial till is at a depth of 20 to 40 inches.

Philippa soils are in cirques and on lateral moraines. They formed in a mixture of volcanic ash, colluvium, and ablation till over dense glacial till. Typically, the surface layer is sandy loam. The subsoil is gravelly silt loam and very gravelly sandy loam. Ortstein is at a depth of 20 to 40 inches.

Of minor extent in this unit are Blethen, Kaleetan, Marblemount, Melakwa, Skykomish, Teneriffe, and Welcome soils and Rock outcrop.

This unit is used for woodland, recreational areas, and wildlife habitat. In the areas used for woodland, the main limitation is occasional snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

12. Pitcher

Very deep, well drained, gently sloping to very steep soils on mountain back slopes

This map unit is in the central part of the survey area. Slopes are 8 to 65 percent. The vegetation is trees and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is 55 to 80 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is 135 to 155 days.

This unit makes up about 6 percent of the survey area. It is about 55 percent Pitcher soils and 45 percent soils of minor extent.

Pitcher soils formed in volcanic ash over colluvium and residuum derived from andesite or breccia and tuff. Typically, the surface layer is sandy loam. The subsoil is gravelly sandy loam and very gravelly loam. The substratum is extremely gravelly sandy loam.

Of minor extent in this unit are Jonas, Kaleetan, Littlejohn, Olomount, and Pheeney soils.

This unit is used for woodland, recreational areas, and wildlife habitat. In the areas used for woodland, the main limitation is occasional snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

Soils on Terraces, Foothills, and Till Plains

These soils make up about 24 percent of the survey area. They are nearly level to very steep. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is 40 to 100 inches, and the average annual air temperature is 45 to 50 degrees F. The average frost-free period is 120 to 200 days.

These soils are moderately deep and very deep and are somewhat excessively drained, moderately well drained, well drained, and somewhat poorly drained. They formed in alluvium, colluvium, back slope alluvium derived from glacial drift, material weathered from andesite and breccia, volcanic ash, pumice, glacial till, and glacial outwash.

These soils are used mainly for woodland, hay and pasture, recreational areas, and wildlife habitat.

13. Barneston-Klaus-Skykomish

Moderately deep and very deep, somewhat excessively drained and well drained, nearly level to very steep soils on terraces and terrace escarpments

This map unit is throughout the survey area. Slopes are 0 to 65 percent. The vegetation is conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is 50 to 100 inches, and the average annual air temperature is 45 to 50 degrees F. The average frost-free period is 120 to 190 days.

This unit makes up about 9 percent of the survey area. It is about 55 percent Barneston soils, 15 percent Klaus soils, 9 percent Skykomish soils, and 21 percent soils of minor extent.

Barneston soils are very deep and somewhat excessively drained. They formed in a mixture of volcanic ash and glacial outwash. Typically, the surface layer is gravelly coarse sandy loam. The subsoil is very gravelly sandy loam and extremely gravelly sand.

Klaus soils are moderately deep and well drained. They formed in a mixture of volcanic ash and alluvium over glacial outwash. Typically, the surface layer is sandy loam. The subsoil is gravelly sandy loam and very gravelly sand. Iron-cemented material is at a depth of 40 to 60 inches.

Skykomish soils are very deep and somewhat excessively drained. They formed in a mixture of volcanic ash and glacial outwash. Typically, the surface layer is gravelly sandy loam. The subsoil is very gravelly sandy loam and very gravelly loamy sand. The substratum is extremely gravelly coarse sand.

Of minor extent in this unit are Alderwood, Cinebar, Elwell, Norma, Ogarty, Olomount, Persis, Ragnar, and Rober soils and stony areas.

This unit is used for woodland, recreational areas, and wildlife habitat. The main limitation in areas of the Barneston soils used for hay and pasture is a low available water capacity. The main limitation in areas of the Klaus and Skykomish soils used for woodland is snowpack. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

14. Tokul-Blethen-Ogarty

Moderately deep and very deep, moderately well drained and well drained, nearly level to very steep soils in valleys and on mountain foot slopes, back slopes, side slopes, toe slopes, and drift plain escarpments

This map unit is in the western part of the survey area. Slopes are 0 to 90 percent. The vegetation is conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is 50 to 75 inches, and the average annual air temperature is 46 to 50 degrees F. The average frost-free period is 150 to 180 days.

This unit makes up about 8 percent of the survey area. It is about 39 percent Tokul soils, 21 percent Blethen soils, 13 percent Ogarty soils, and 27 percent soils of minor extent.

Tokul soils are on mountain foot slopes and in valleys. They are moderately deep and moderately well drained. They formed in a mixture of volcanic ash and dense glacial till. Typically, the surface layer is gravelly loam. The subsoil also is gravelly loam. The substratum is gravelly fine sandy loam. Ortstein is at a depth of 20 to 40 inches.

Blethen soils are on mountain back slopes, side slopes, toe slopes, and drift plain escarpments. They are very deep and well drained. They formed in colluvium and slope alluvium derived from glacial drift. The colluvium and alluvium have an admixture of volcanic ash. Typically, the surface layer is gravelly loam. The subsoil is very gravelly loam, very gravelly sandy loam, and extremely gravelly sandy loam. The substratum is extremely gravelly loamy sand.

Ogarty soils are on back slopes in the foothills. They are moderately deep and well drained. They formed in a mixture of volcanic ash, colluvium, and residuum derived from andesite and breccia. Typically, the surface layer is gravelly loam. The subsoil is very gravelly sandy loam and extremely gravelly fine sandy loam. The substratum is extremely gravelly fine sandy loam. Fractured andesite is at a depth of 20 to 40 inches.

Of minor extent in this unit are Barneston, Beausite, and Pastik soils.

This unit is used for woodland, hay and pasture, recreational areas, and wildlife habitat. The main limitations in areas of the Tokul soils used for hay and pasture are a seasonal high water table and the hazard of erosion. The water table is the main limitation in the areas used for woodland. Few limitations affect the use of the Blethen and Ogarty soils for woodland. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

15. Tokul

Moderately deep, moderately well drained, nearly level to very steep soils in glacially modified areas on mountain foot slopes and in valleys

This map unit is in the northwestern part of the survey area. Slopes are 0 to 90 percent. The vegetation is conifers and shrubs. Elevation is 600 to 1,100 feet. The average annual precipitation is 50 to 70 inches,

and the average annual air temperature is about 50 degrees F. The average frost-free period is 160 to 180 days.

This unit makes up about 4 percent of the survey area. It is about 73 percent Tokul soils and 27 percent soils of minor extent.

Tokul soils formed in a mixture of volcanic ash and dense glacial till. Typically, the surface layer is gravelly loam. The subsoil also is gravelly loam. The substratum is gravelly fine sandy loam. Ortstein is at a depth of 20 to 40 inches.

Of minor extent in this unit are Barneston, Beausite, Norma, and Pastik soils and Rock outcrop.

This unit is used for woodland, recreational areas, and wildlife habitat. The main limitation in the areas used for woodland is seasonal wetness. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

16. Mashel-Scamman-National

Very deep, moderately well drained, somewhat poorly drained, and well drained, nearly level to very steep soils on terraces and foothill back slopes

This map unit is in the southwestern part of the survey area. Slopes are 0 to 65 percent. The vegetation is conifers and shrubs. Elevation is 700 to 1,800 feet. The average annual precipitation is 40 to 85 inches, and the average annual air temperature is 46 to 50 degrees F. The average frost-free period is 155 to 200 days.

This unit makes up about 3 percent of the survey area. It is about 41 percent Mashel soils, 23 percent Scamman soils, 18 percent National soils, and 18 percent soils of minor extent.

Mashel soils are on back slopes in the foothills. They are moderately well drained. They formed in glacial till. Typically, the surface layer is silt loam. The subsoil is silt loam, silty clay loam, and silty clay.

Scamman soils are on terraces and foothill back slopes. They are somewhat poorly drained. They formed in glacial and sedimentary material. Typically, the surface layer and subsurface layer are silt loam. The subsoil is silty clay.

National soils are on terraces. They are well drained. They formed in volcanic ash and pumice over alluvium. Typically, the surface layer is cindery sandy loam. The subsoil is very cindery loamy sand and loam. The substratum is silt loam.

Of minor extent in this unit are Cinebar, Greenwater, and Wilkeson soils and ponded areas.

This unit is used for woodland, hay and pasture, recreational areas, and wildlife habitat. The main limitation in areas of the Mashel soils used for woodland is seasonal wetness. The Scamman soils are suitable for hay and pasture. If irrigated, the National soils also are suitable for hay and pasture. The slope and the hazard of erosion are management concerns in areas where the slope is more than 30 percent.

Soils on Flood Plains, Terraces, and Till Plains and in River Valleys

These soils make up about 1 percent of the survey area. They are nearly level. The native vegetation is mainly conifers and shrubs. Elevation is 30 to 800 feet. The average annual precipitation is 35 to 70 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is 140 to 200 days.

These soils are very deep and are well drained, moderately well drained, and very poorly drained. They formed in alluvium and organic deposits.

These soils are used mainly for crops, homesites, woodland, recreational areas, and wildlife habitat.

17. Edgewick-Seattle-Nooksack

Very deep, well drained, moderately well drained, and very poorly drained, nearly level soils on river terraces, on flood plains, in river valleys, and on glacial till plains

This map unit is in the northwestern part of the survey area. Slopes are 0 to 3 percent. The vegetation is conifers and shrubs. Elevation is 30 to 800 feet. The average annual precipitation is 35 to 70 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is 140 to 200 days.

This unit makes up about 1 percent of the survey area. It is about 32 percent Edgewick soils, 24 percent Seattle soils, 23 percent Nooksack soils, and 21 percent soils of minor extent.

Edgewick soils are on river terraces. They are well drained. They formed in alluvium. Typically, the surface layer is silt loam. The subsoil is silt loam, fine sandy loam, loamy sand, and very gravelly sand.

Seattle soils are in river valleys and on glacial till plains. They are very poorly drained. They formed in herbaceous and woody organic deposits. Typically, the surface layer is muck. The underlying layers are stratified, sapric and hemic material.

Nooksack soils are on flood plains and river terraces. They are moderately well drained. They formed in alluvium. Typically, the surface layer, subsoil, and substratum are silt loam.

Of minor extent in this unit are Belfast, Oridia, Pastik, and Puget soils.

This unit is used for crops, hay and pasture,

woodland, recreational areas, and wildlife habitat. The main limitation in the areas used for crops, hay, or pasture is a seasonal high water table. The main limitations in the areas used for woodland or homesite development are seasonal wetness and occasional flooding in areas of the Edgewick and Nooksack soils and a high water table and low bearing strength in the Seattle soils.

Broad Land Use Considerations

The general soil map is useful in determining the potential of the soils in an area for a general land use pattern. It is not suitable for selecting a specific site for a specific use or for designing management programs on individual farms. Specific information that is helpful in designing a detailed land use plan is given in the section "Detailed Soil Map Units" and in the tables.

About 90 percent of the survey area is covered by forests, which are in various stages of growth. The main land use is the production of timber. The productivity of western hemlock and Douglas fir is high in general soil map units 6, 7, 8, 11, 12, 14, and 15; moderate in map units 5, 9, 10, 13, and 16; and low in map units 1, 2, 3, and 4. Generally, productivity decreases as elevation increases and as the proportion of rock fragments in the soil increases.

The slope and the hazard of erosion are management concerns in many of the wooded areas. Carefully constructing logging roads minimizes erosion and the sedimentation of streams. The use of tracked or wheeled equipment when the soil is moist compacts the soil and results in the formation of ruts. This equipment should be used only during the dry summer months.

Less than 2 percent of the survey area is used for hay and pasture. Most of the hayland and pasture is in general soil map units 14, 16, and 17. The soils in map unit 17 are subject to flooding during winter and early spring. The flooding causes minimal crop damage.

The recreational activities in the survey area include hiking, horseback riding, hunting, cross-country skiing, and downhill skiing. The potential for recreational development ranges from low to high, depending on the intensity of the expected use and the properties of the soil.

The potential for wildlife habitat is high throughout the survey area. The soils in map units 1 through 16 have high potential for woodland wildlife habitat. The soils in map unit 17 have high potential for openland wildlife habitat.

Detailed Soil Map Units

The map units delineated on the detailed maps at the back of this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit is given under "Use and Management of the Soils."

A map unit delineation on a map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying layers, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying layers. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Kaleetan sandy loam, windswept, 30 to 65 percent slopes, is a phase of the Kaleetan series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are called complexes. A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar

in all areas. Klaber-Cinebar silt loams, 0 to 8 percent slopes, is an example.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The "Glossary" defines many of the terms used in describing the soils or miscellaneous areas.

Map Unit Descriptions

1—Alderwood gravelly loam, 6 to 15 percent slopes. This moderately well drained soil is in glacially modified areas on foothills and in valleys. It is moderately deep to ortstein. It formed in dense glacial till. The native vegetation is mainly confers and shrubs. Elevation is 50 to 800 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 200 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 1.5 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly loam. The upper 14 inches of the subsoil is dark yellowish brown very gravelly loam. The lower 13 inches is dark yellowish brown very gravelly sandy loam. Grayish brown ortstein that crushes to very gravelly sandy loam is at a depth of about 33 inches. Below the ortstein is grayish brown, dense glacial till that crushes to very cobbly fine sandy loam. The depth to dense glacial till ranges from 20 to 40 inches. In some areas the surface layer is gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or is 40 to 60 inches deep to cemented glacial till.

Included in this unit are small areas of Beausite, Everett, Lynnwood, Norma, and Ovall soils and Alderwood soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Alderwood soil and very slow in the ortstein. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from December through May. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used as pasture or cropland, however, runoff is medium and the hazard of erosion is moderate.

This unit is used mainly as woodland. It also is used as pasture or cropland.

In the areas used as pasture or cropland, the main limitations are the slope and the muddiness caused by seasonal wetness. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and Pacific madrone. The common forest understory plants are salal, Oregongrape, western brackenfern, western swordfern, and evergreen huckleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 146. On the basis of a 50-year site curve, it is 111. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 153 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs periodically. Seedlings that are planted or naturally established in the less fertile subsoil grow poorly and lack vigor. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting

depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

2—Alderwood gravelly loam, 15 to 30 percent slopes. This moderately well drained soil is on glacially modified foothills. It is moderately deep to ortstein. It formed in dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 800 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 200 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 1.5 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly loam. The upper 14 inches of the subsoil is dark yellowish brown very gravelly loam. The lower 13 inches is dark yellowish brown very gravelly sandy loam. Grayish brown ortstein that crushes to very gravelly sandy loam is at a depth of about 33 inches. Below the ortstein is grayish brown, dense glacial till that crushes to very cobbly fine sandy loam. The depth to dense glacial till ranges from 20 to 40 inches. In some areas the surface layer is gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, has weathered bedrock at a depth of 40 to 60 inches, or is 40 to 60 inches deep to cemented glacial till.

Included in this unit are small areas of Everett, Kanaskat, Lynnwood, and Ovall soils and Alderwood soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Alderwood soil and very slow in the ortstein. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from December through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and Pacific madrone. The common forest understory plants are salal, Oregongrape, western brackenfern, western swordfern, and evergreen huckleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 146. On the basis of a 50-year site curve, it is 111. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 153 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected from unmanaged fires in undisturbed areas. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs periodically. Seedlings that are planted or naturally established in the less fertile subsoil grow poorly and lack vigor. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

3—Alkiridge sandy loam, 8 to 30 percent slopes. This moderately well drained soil is in cirque basins and on the adjacent valley floors. It is moderately deep to dense glacial till. It formed in volcanic ash, pumice, and cinders over dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 2,700 to 3,700 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, litter, and moss 1 inch thick. When mixed to a depth of 7 inches, the surface layer is dark brown sandy loam. The upper 11 inches of the subsoil is dark brown gravelly sandy loam. The lower 19 inches is dark yellowish brown and olive brown very gravelly loam. Brown, dense glacial till that crushes to very gravelly

sandy loam is at a depth of about 37 inches. The dense glacial till is similar to a cemented pan. The depth to dense glacial till ranges from 20 to 40 inches.

Included in this unit are small areas of Haywire and Nagrom soils and Alkiridge soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Alkiridge soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Douglas fir, and western redcedar. The common forest understory plants are common beargrass, Oregongrape, salal, black mountain huckleberry, western swordfern, bunchberry dogwood, and Pacific trillium.

On the basis of a 100-year site curve, the mean site index for western hemlock is 132. On the basis of a 50-year site curve, it is 95. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 202 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. A moderate reduction in productivity can be expected from unmanaged fires in undisturbed areas. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

4—Altapeak gravelly sandy loam, 8 to 30 percent slopes. This deep, well drained soil is on mountain slopes. It formed in volcanic ash and pumice mixed with residuum and colluvium over granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 5,600 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 10 inches of the subsoil is dark reddish brown very gravelly sandy loam. The lower 8 inches is strong brown very cobbly loamy sand. The substratum extends to a depth of 50 inches. It is pale yellow and grayish brown extremely cobbly loamy sand and extremely gravelly coarse sand. Highly weathered granodiorite is at a depth of about 50 inches. The depth to granitic or metamorphic rocks ranges from 40 to 60 inches. In some areas the surface layer is loamy sand, sandy loam, or gravelly loam. In other areas the soil is underlain by conglomerate.

Included in this unit are small areas of Serene soils, soils that are 10 to 20 inches deep over bedrock, Rock outcrop, and Altapeak soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Altapeak soil. Available water capacity is low. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Alaska cedar, and mountain hemlock. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, huckleberry, princes pine, deer fern, lupine, salal, and cascade azalea.

On the basis of a 100-year site curve, the mean site

index for western hemlock is estimated to be 88. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 102 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. A moderate reduction in productivity can be expected from unmanaged fires in undisturbed areas. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the hazard of displacement.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIe.

5—Altapeak gravelly sandy loam, 30 to 65 percent slopes. This deep, well drained soil is on mountain slopes. It formed in volcanic ash and pumice mixed with residuum and colluvium over granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 5,600 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 10 inches of the subsoil is dark reddish brown very gravelly sandy loam. The lower 8 inches is strong brown very cobbly loamy sand. The substratum extends to a depth of 50 inches. It is pale yellow and grayish brown extremely cobbly loamy sand and extremely gravelly coarse sand. Highly weathered granodiorite is at a depth of about 50 inches. The depth to granitic or metamorphic rocks ranges from 40 to 60 inches. In some areas the surface layer is loamy sand, sandy loam, or gravelly loam. In other areas the soil is underlain by conglomerate.

Included in this unit are small areas of Haywire and Serene soils, soils that are 10 to 20 inches deep over bedrock, Rock outcrop, and Altapeak soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Altapeak soil. Available water capacity is low. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Alaska cedar, and mountain hemlock. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, blue huckleberry, princes pine, deer fern, lupine, salal, and cascade azalea.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 88. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 102 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for

road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and the hazard of erosion.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIIe.

6—Altapeak gravelly sandy loam, 65 to 90 percent slopes. This deep, well drained soil is on mountain slopes. It formed in volcanic ash and pumice mixed with residuum and colluvium over granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 5,600 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 10 inches of the subsoil is dark reddish brown very gravelly sandy loam. The lower 8 inches is strong brown very cobbly loamy sand. The substratum extends to a depth of 50 inches. It is pale yellow and grayish brown extremely cobbly loamy sand and extremely gravelly coarse sand. Highly weathered granodiorite is at a depth of about 50 inches. The depth to granitic or metamorphic rocks ranges from 40 to 60 inches. In some areas the surface layer is loamy sand, sandy loam, or gravelly loam. In other areas the soil is underlain by conglomerate.

Included in this unit are small areas of Haywire and Serene soils, soils that are 10 to 20 inches deep over bedrock, Rock outcrop, and Altapeak soils that have slopes of less than 65 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Altapeak soil. Available water capacity is low. The effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Alaska cedar, and mountain hemlock. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, blue huckleberry, princes pine, deer fern, lupine, salal, and cascade azalea.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 88. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 102 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the

surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock or Pacific silver fir occurs periodically.

This unit is in capability subclass VIIe.

7—Altapeak-Rock outcrop complex, 45 to 90 percent slopes. This map unit is on mountain slopes. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 5,600 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

This unit is 45 percent Altapeak gravelly sandy loam and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Reggad, Serene, and Treen soils, talus, soils that are 10 to 20 inches deep over bedrock, and Altapeak soils that have slopes of less than 45 percent. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

The Altapeak soil is deep and well drained. It formed in volcanic ash and pumice mixed with residuum and colluvium over granitic and metamorphic rocks. Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 10 inches of the subsoil is dark reddish brown very gravelly sandy loam. The lower 8 inches is strong brown very cobbly loamy sand. The substratum extends to a depth of 50 inches. It is pale yellow and grayish brown extremely cobbly loamy sand and extremely gravelly coarse sand. Highly weathered granodiorite is at a depth of about 50 inches. The depth to granitic or metamorphic rocks ranges from 40 to 60 inches. In some areas the surface layer is loamy sand, sandy loam, or gravelly loam. In other areas the soil is underlain by conglomerate.

Permeability is moderately rapid in the Altapeak soil. Available water capacity is low. The effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is granitic or metamorphic rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Alaska cedar, and mountain hemlock. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, blue huckleberry, princes pine, deer fern, lupine, salal, and cascade azalea.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 88. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 102 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 30 percent of this unit.

The main limitations affecting timber harvesting are snowpack, the Rock outcrop, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation.

The Altapeak soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

8—Andic Cryumbrepts, 30 to 90 percent slopes. These moderately deep to very deep, well drained soils are on cirque sidewalls. They formed in volcanic ash, glacial till, and colluvium derived from basalt and andesite. The native vegetation is mainly conifers and shrubs. Elevation is 4,000 to 6,500 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

No single profile is representative of these soils. One of the more commonly observed ones, however, is covered with a mat of needles and twigs about 0.5 inch thick. Typically, the surface layer is very dark grayish brown very gravelly sandy loam 5 inches thick. The upper 11 inches of the subsoil is dark yellowish brown very gravelly sandy loam. The lower 28 inches is dark brown extremely gravelly sandy loam. Andesite is at a depth of about 44 inches. The depth to bedrock is 20 to more than 60 inches. The content of rock fragments ranges from 25 to 75 percent. The dark surface layer is 7 to 15 inches thick.

Included in this unit are small areas of Haywire soils and Rock outcrop. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Andic Cryumbrepts. Available water capacity is low. The effective rooting depth is 20 to more than 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are subalpine fir and mountain hemlock. The common forest understory plants are pinemat manzanita, black mountain huckleberry, lupine, dwarf huckleberry, and bitter cherry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 74. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 79 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. During an average year, snowpack limits the use of equipment and restricts access from November through April. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are slippery and soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. The areas most susceptible to landslides are those underlain by dense glacial till. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Equipment and logs on the surface result in a high degree of soil compaction when the soils are moist and a high degree of puddling when the soils are wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock, mountain hemlock, or Pacific silver fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs periodically. Because the rooting depth is restricted by the glacial till and bedrock in some areas,

trees are occasionally subject to windthrow when the soils are wet and winds are strong.

This unit is in capability subclass VIIe.

9—Arents, 0 to 8 percent slopes. These moderately deep to very deep, moderately well drained to somewhat excessively drained soils formed in a mixture of volcanic ash and a variety of glacial deposits. They are on terraces and drift plains. Elevation is 1,000 to 3,000 feet. The average annual precipitation is about 45 to 90 inches, and the average annual air temperature is about 42 to 48 degrees F. The average frost-free period is about 125 days.

No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface layer is dark yellowish brown gravelly sandy loam about 35 inches thick. The underlying material to a depth of 60 inches is dark yellowish brown extremely gravelly sand. The depth to dense glacial till ranges from 30 to more than 60 inches. In many areas the surface layer is dark brown very gravelly loam.

Included in this unit are small areas of Alderwood, Barneston, Chinkmin, Norma, Persis, Ragnar, Skykomish, and Tokul soils. Included areas make up about 10 percent of the total acreage.

Permeability is moderate or moderately rapid in the Arents. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

These soils vary too much to be rated for potential uses. Onsite evaluation is needed. These are disturbed soils. They are used as sites for mill yards, sorting yards, parking lots, mills, dams, and old towns. Some areas are reverting to trees.

This unit is in capability subclass IVs.

10—Barneston gravelly coarse sandy loam, 0 to 6 percent slopes. This very deep, somewhat excessively drained soil is on outwash terraces. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 180 days.

Typically, the surface is covered with a mat of needles, decomposed roots, leaves, and twigs 2 inches thick. The surface layer is dark grayish brown gravelly coarse sandy loam 9 inches thick. The subsoil is dark yellowish brown very gravelly sandy loam 5 inches thick. The upper 7 inches of the substratum is dark brown extremely gravelly sand. The lower part to a depth of 60 inches is dark yellowish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 14 to 20 inches. In some areas the surface layer is gravelly loam, gravelly sandy loam, very gravelly sandy loam, or very gravelly coarse sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, has a substratum of extremely gravelly sand at a depth of 24 to 36 inches, has a better developed subsoil, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Alderwood, Norma, and Ragnar soils, Barneston soils that have a stony surface, and Barneston soils that have slopes of more than 6 percent. Included areas make up about 10 to 35 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture and as a source of aggregate. In the areas used for hay and pasture, the main limitation is the low available water capacity.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock and western redcedar. The common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 135. On the basis of a 50-year site curve, it is 105. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 138 cubic feet per acre per year, occurring at age 70.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are

available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of planted Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

11—Barneston gravelly coarse sandy loam, 6 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, decomposed roots, leaves, and twigs 2 inches thick. The surface layer is dark grayish brown gravelly coarse sandy loam 9 inches thick. The subsoil is dark yellowish brown very gravelly sandy loam 5 inches thick. The upper 7 inches of the substratum is dark brown extremely gravelly sand. The lower part to a depth of 60 inches is dark yellowish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 14 to 20 inches. In some areas the surface layer is gravelly loam, gravelly sandy loam, very gravelly sandy loam, or very gravelly coarse sandy loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, has a substratum of extremely gravelly sand at a depth of 24 to 36 inches, has a better developed subsoil, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Nargar, Norma, Ogarty, and Tokul soils and Barneston soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used as a source of aggregate.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock and western redcedar. The common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 135. On the basis of a 50-year site curve, it is 105. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 138 cubic feet per acre per year, occurring at age 70.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

12—Barneston gravelly coarse sandy loam, 30 to 65 percent slopes. This very deep, somewhat excessively drained soil is on outwash terraces and terrace escarpments. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, decomposed roots, leaves, and twigs 2 inches thick. The surface layer is dark grayish brown gravelly coarse sandy loam 9 inches thick. The subsoil is dark yellowish brown very gravelly sandy loam 5 inches thick. The upper 7 inches of the substratum is dark brown extremely gravelly sand. The lower part to a depth of 60 inches is dark yellowish brown extremely gravelly sand. The depth to extremely gravelly sand

ranges from 14 to 20 inches. In some areas the surface layer is gravelly loam, gravelly sandy loam, very gravelly sandy loam, or very gravelly coarse sandy loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, has a substratum of extremely gravelly sand at a depth of 24 to 36 inches, has a better developed subsoil, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Nargar, Ogarty, and Tokul soils and Barneston soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It also is used as a source of aggregate.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock and western redcedar. The common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 145. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 152 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

13—Barneston gravelly sandy loam, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 9 inches, the surface layer is dark grayish brown gravelly sandy loam. The subsoil is dark yellowish brown very gravelly sandy loam 8 inches thick. The substratum to a depth of 60 inches is extremely gravelly sand. It is variegated but is dominantly grayish brown. The depth to extremely gravelly sand ranges from 14 to 20 inches. In some areas the surface layer is very gravelly loam, very gravelly sandy loam, or cobbly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, has a substratum of extremely gravelly sand at a depth of 24 to 36 inches, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Nargar, Ogarty, and Tokul soils, Norma soils in depressions, and Barneston soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used as a source of aggregate.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock and western redcedar. The common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 150. On the basis of a 50-year

site curve, it is 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

14—Barneston gravelly sandy loam, 8 to 30 percent slopes. This very deep, somewhat excessively drained soil is on outwash terraces and terrace escarpments. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 700 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 49 degrees F. The average frost-free period is about 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 9 inches, the surface layer is dark grayish brown gravelly sandy loam. The subsoil is dark yellowish brown very gravelly sandy loam 8 inches thick. The substratum to a depth of 60 inches is extremely gravelly sand. It is variegated but is dominantly grayish brown. The depth to extremely gravelly sand ranges from 14 to 20 inches. In some areas the surface layer is very gravelly loam, very gravelly sandy loam, or gravelly loam. In other areas the soil has a substratum of very gravelly sand at a depth of 24 to 36 inches, has 15 to 35 percent rock fragments in the subsoil, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Alderwood and Ragnar soils, Barneston soils that have a stony surface, and Barneston soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used as a source of aggregate.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock and western redcedar. The common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 150. On the basis of a 50-year site curve, it is 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of planted Douglas fir

seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

15—Barneston gravelly sandy loam, 30 to 65 percent slopes. This very deep, somewhat excessively drained soil is on outwash terrace escarpments. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 700 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 49 degrees F. The average frost-free period is about 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 9 inches, the surface layer is dark grayish brown gravelly sandy loam. The subsoil is dark yellowish brown very gravelly sandy loam 8 inches thick. The substratum to a depth of 60 inches is extremely gravelly sand. It is variegated but is dominantly grayish brown. The depth to extremely gravelly sand ranges from 14 to 20 inches. In some areas the surface layer is very gravelly loam, very gravelly sandy loam, or gravelly loam. In other areas the soil has a substratum of very gravelly sand at a depth of 24 to 36 inches, has 15 to 35 percent rock fragments in the subsoil, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Alderwood and Ragnar soils, Barneston soils that have a stony surface, and Barneston soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It also is used as a source of aggregate.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock and western redcedar. The common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 150. On the basis of a 50-year site curve, it is 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the slope. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment and mortality are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of planted Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

16—Barneston gravelly sandy loam, windswept, 6 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,400 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 9 inches, the surface layer is dark grayish brown gravelly sandy loam. The subsoil is yellowish brown very gravelly sandy loam 8 inches thick. The substratum to a depth of 60 inches is extremely gravelly sand. It is variegated but is dominantly grayish brown. The depth to extremely gravelly sand ranges from 14 to 20 inches. In some areas the surface layer is very gravelly loam, very gravelly sandy loam, or cobbly loam. In other areas the subsoil has less than 35 percent rock

fragments, the substratum of extremely gravelly sand is at a depth of 24 to 36 inches, or the substratum is very gravelly sandy loam.

Included in this unit are small areas of Nargar, Ogarty, and Tokul soils, Norma soils in depressions, and Barneston soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used as a source of aggregate.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock and western redcedar. The common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 133. On the basis of a 50-year site curve, it is estimated to be 100. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 134 cubic feet per acre per year, occurring at age 70. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

17—Beausite gravelly loam, 6 to 30 percent slopes. This well drained soil is on foothills. It is moderately deep to sandstone. It formed in glacial till and in colluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,500 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The upper 5 inches of the surface layer is black gravelly loam. The lower 6 inches is dark brown very gravelly loam. The upper 18 inches of the subsoil is dark brown and dark yellowish brown extremely gravelly sandy loam. The lower part is light olive brown extremely gravelly sandy loam 7 inches thick. Sandstone is at a depth of about 36 inches. The depth to sandstone ranges from 24 to 40 inches. In some areas the surface layer is gravelly sandy loam. In other areas the soil is 40 to 60 inches deep to sandstone or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Tokul soils and Beausite soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Beausite soil. Available water capacity is low. The effective rooting depth is 24 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, Oregongrape, oceanspray, red huckleberry, blueleaved huckleberry, and swordfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 155. On the basis of a 50-year site curve, it is 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 164 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. The rock available for road construction is poor-quality

sandstone. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

18—Beausite gravelly loam, 30 to 65 percent slopes. This well drained soil is on foothills. It is moderately deep to sandstone. It formed in glacial till and in colluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,500 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The upper 5 inches of the surface layer is black gravelly loam. The lower 6 inches is dark yellowish brown very gravelly sandy loam. The upper 18 inches of the subsoil is dark brown and dark yellowish brown extremely gravelly sandy loam. The lower part is light olive brown extremely gravelly sandy loam 7 inches thick. Sandstone is at a depth of about 36 inches. The depth to sandstone ranges from 24 to 40 inches. In some areas the surface layer is gravelly sandy loam. In other areas the soil is 40 to 60 inches deep to sandstone or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Tokul soils and Beausite soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Beausite soil. Available water capacity is low. The effective rooting depth is 24 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, Oregongrape, oceanspray, red huckleberry, blueleaved huckleberry, and swordfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 155. On the basis of a 50-year site curve, it is 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 164 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

19—Beausite gravelly loam, 65 to 90 percent slopes. This well drained soil is on foothills. It is moderately deep to sandstone. It formed in glacial till and in colluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,500 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The upper 5 inches of the surface layer is black gravelly loam. The lower 6 inches is dark brown very gravelly loam. The upper 18 inches of the subsoil is dark brown and dark yellowish brown extremely gravelly sandy loam. The lower part is light olive brown extremely gravelly sandy loam 7 inches thick. Sandstone is at a depth of about 36 inches. The depth to sandstone ranges from 24 to 40 inches. In some areas the surface layer is gravelly sandy loam. In other areas the soil is 40 to 60 inches deep to sandstone or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Tokul soils and Beausite soils that have slopes of less than 65 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Beausite soil. Available water capacity is low. The effective rooting depth is 24 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, Oregongrape, oceanspray, red huckleberry, blueleaved huckleberry, and swordfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 150. On the basis of a 50-year site curve, it is 111. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

20—Belfast silt loam, 0 to 2 percent slopes. This very deep, moderately well drained soil is on terraces. It formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 120 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface layer is brown silt loam 7 inches thick. The upper 9 inches of the underlying material is brown silt loam. The next 22 inches is brown and pale brown fine sandy loam. The lower part to a depth of 60 inches is grayish brown, stratified fine sandy loam and loamy fine sand. In some areas the surface layer is loam or very fine sandy loam. In other areas the soil has less than 50 percent base saturation in the surface layer or has a sandy substratum.

Included in this unit are small areas of Nooksack and Oridia soils and Belfast soils that have slopes of more than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Belfast soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3.5 to 6.0 feet from November through March. Runoff is very slow, and there is no hazard of erosion.

This soil is subject to occasional, brief periods of flooding from November through March. Channeling and deposition are common along streambanks.

This unit is used mainly as hayland, pasture, or cropland. It also is used as woodland and as a site for homes.

In the areas used for hay and pasture, proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. In summer, irrigation is required for maximum production.

The main hazard in the areas used as cropland is the flooding. This unit is suited to all of the crops commonly grown in the survey area. The principal crops are oats and corn silage. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are black cottonwood, red alder, bigleaf maple, and western redcedar. The common forest understory plants are brackenfern, western swordfern, salal, Oregongrape, vine maple, trailing blackberry, and salmonberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 160. On the basis of a 50-year site curve, it is estimated to be 120. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 170 cubic feet per acre per year, occurring at age 65.

The main hazard affecting timber harvesting is the flooding, which limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

In the areas used for homesite development, the main hazard is the flooding. The main limitations on sites for septic tank absorption fields are a poor filtering capacity in the substratum and the flooding. Septic tank absorption fields may not function properly during rainy periods because of wetness. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

This unit is in capability subclass IIIw.

21—Bellicum very cindery loamy sand, 8 to 30 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in a mantle of pumice and volcanic ash over residuum and colluvium derived dominantly from porphyritic andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 6 inches, the surface layer is strong brown very cindery loamy sand. The upper 15 inches of the subsoil is yellowish red and grayish brown extremely cindery loamy sand. The lower 18 inches is dark yellowish brown very cobbly sandy loam. The substratum is dark yellowish brown extremely cobbly sandy loam 13 inches thick. Fractured andesite is at a depth of about 52 inches. The depth to andesite ranges from 40 to 60 inches. In some areas the surface layer is cindery loamy sand or loamy sand. In other areas, the soil is more than 60 inches deep over bedrock or the bedrock is sandstone.

Included in this unit are small areas of Bromo soils and Bellicum soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Bellicum soil. Available water capacity also is moderate. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, Pacific silver fir, and western redcedar. The common forest understory plants are Oregongrape, red huckleberry, salal, western swordfern, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index is 141 for Douglas fir and 160 for western hemlock. On the basis of a 50-year site curve, it is 112 for Douglas fir and western hemlock. The highest

average growth rate in unmanaged, even-aged stands of Douglas fir is 146 cubic feet per acre per year, occurring at age 65. For western hemlock it is 254 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or Pacific silver fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Seedlings that are planted or naturally established in the less fertile subsoil grow poorly and lack vigor. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants hinders the growth of the seedlings. Competing vegetation can be controlled by mechanical or chemical means. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass IVe.

22—Bellicum very cindery loamy sand, 30 to 65 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in a mantle of pumice and volcanic ash over residuum and colluvium derived dominantly from porphyritic andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 6 inches, the surface layer is strong brown very cindery loamy sand. The upper 15 inches of the subsoil is yellowish red and grayish brown extremely cindery loamy sand. The lower 18 inches is dark yellowish brown very cobbly sandy loam. The substratum is dark yellowish brown extremely cobbly sandy loam 13 inches thick. Fractured andesite is at a depth of about 52 inches. The depth to andesite ranges from 40 to 60 inches. In some areas the surface layer is cindery loamy sand or loamy sand. In other areas, the soil is more than 60 inches deep over bedrock or the bedrock is sandstone.

Included in this unit are small areas of Bromo soils and Bellicum soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Bellicum soil. Available water capacity also is moderate. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, Pacific silver fir, and western redcedar. The common forest understory plants are Oregongrape, red huckleberry, salal, western swordfern, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index is 141 for Douglas fir and 160 for western hemlock. On the basis of a 50-year site curve, it is 112 for Douglas fir and western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 146 cubic feet per acre per year, occurring at age 65. For western hemlock it is 254 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged

fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or Pacific silver fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Seedlings that are planted or naturally established in the less fertile subsoil grow poorly and lack vigor. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass VIIe.

23—Blethen gravelly loam, 5 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes and toe slopes. It formed in colluvium and slope alluvium derived from glacial drift. The colluvium and alluvium have an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. The surface layer is very dark grayish brown gravelly loam 5 inches thick. The upper 19 inches of the subsoil is dark brown very gravelly loam and very gravelly sandy loam. The lower 18 inches is dark yellowish brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown extremely gravelly loamy sand. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Barneston, Ogarty, and Tokul soils and Blethen soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Blethen soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, bigleaf maple, and western redcedar. The common forest understory plants are salal, Oregongrape, vine maple, red huckleberry, western swordfern, longtube twinflower, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 149. On the basis of a 50-year site curve, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

24—Blethen gravelly loam, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in colluvium and slope alluvium derived from glacial drift. The colluvium and alluvium

have an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. The surface layer is very dark grayish brown gravelly loam 5 inches thick. The upper 9 inches of the subsoil is dark brown very gravelly loam and very gravelly sandy loam. The lower 18 inches is dark yellowish brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown extremely gravelly loamy sand. In some areas the surface layer is gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Barneston, Ogarty, and Tokul soils, Rock outcrop, and Blethen soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Blethen soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, bigleaf maple, and western redcedar. The common forest understory plants are salal, Oregongrape, vine maple, red huckleberry, western swordfern, longtube twinflower, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 149. On the basis of a 50-year site curve, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment and mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

25—Borohemists, 0 to 2 percent slopes. These very deep, very poorly drained soils are in depressions on river terraces and mountains. They formed in partially decomposed herbaceous plant material over decomposed woody material and in varying amounts of alluvium or mudflow deposits. The native vegetation is mainly shrubs and sedges. Elevation is 1,400 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 160 days.

No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface layer is very dark brown mucky peat about 4 inches thick. The upper 26 inches of the underlying material is very dark grayish brown hemic material. The next 4 inches is very dark grayish brown sandy loam. The lower part to a depth of 60 inches is dark reddish brown hemic material. The depth to hemic material ranges from 20 to more than 60 inches. After rubbing, the overall content of fiber ranges from 20 to 30 percent, although individual layers can have as much as 50 percent. Reaction is extremely acid or very strongly acid.

Included in this unit are small areas of ponded mineral soils and Ohop soils. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Borohemists. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from October through June. Runoff is ponded, and there is no hazard of erosion.

This unit is used for wildlife habitat. The native

vegetation consists of hardhack, cattail, western redcedar, rushes, and sedges.

This unit is in capability subclass Vw.

26—Bromo very cindery sandy loam, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 165 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The upper 4 inches of the surface layer is very dark brown very cindery sandy loam. The lower 9 inches is dark brown and light brownish gray very cindery loamy sand. The subsoil is yellowish red, strong brown, light brownish gray, and reddish yellow very cindery sand about 19 inches thick. The substratum to a depth of 60 inches is dark brown sandy loam. In some areas the surface layer is cindery sandy loam or very cindery loamy sand. In other areas the soil has 15 to 50 percent rock fragments in the lower part of the subsoil and is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Cotteral soils and Bromo soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the upper part of the Bromo soil and moderate in the substratum. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, Pacific silver fir, and bigleaf maple. The common forest understory plants are Oregongrape, western brackenfern, western swordfern, vine maple, and salal.

On the basis of a 100-year site curve, the mean site index is 151 for Douglas fir and western hemlock. On the basis of a 50-year site curve, it is 118 for Douglas fir and 106 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 159 cubic feet per acre per year, occurring at age 60. For western hemlock it is 240 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. During an average year, snowpack limits the use of equipment and restricts access from January through March. Rock for road construction is not readily available. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. Seedlings that are planted or naturally established in the less fertile upper part of the subsoil grow poorly and lack vigor. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass VIIe.

27—Cattcreek very cindery loamy sand, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes and in cirque basins. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation generally is 2,800 to 4,000 feet. Some areas, however, extend to 5,300 feet. The average annual precipitation is about 105 inches, and the average annual air temperature is about 39 degrees F. The average frost-free period is about 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown very cindery loamy sand 7 inches thick. The upper 4 inches of the subsoil is strong brown very cindery loamy sand. The next 10 inches is strong brown very cindery sand. The lower part to a depth of 60 inches is dark yellowish brown and olive brown very gravelly sandy loam. In some areas the surface layer is extremely cindery or cindery loamy sand. In other areas the soil is 40 to 60 inches deep to andesite or sandstone, has 15 to 35 percent rock fragments in the substratum, or is 30 to 60 inches deep to dense glacial till.

Included in this unit are small areas of Cotteral soils and Cattcreek soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the upper part of the Cattcreek soil and moderate in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, western white pine, and Alaska cedar. The common forest understory plants are common beargrass, longtube twinflower, western brackenfern, evergreen blackberry, black mountain huckleberry, princes pine, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 124 for western hemlock and is estimated to be 117 for Douglas fir. On the basis of a 50-year site curve, it is 86 for western hemlock and is estimated to be 90 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 188 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting Douglas fir, noble fir, or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and western hemlock occurs periodically. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass VIIe.

28—Cattcreek very cindery loamy sand, 65 to 90 percent slopes. This very deep, well drained soil is on mountain back slopes and in cirque basins. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation generally is 2,800 to 4,000 feet. Some areas, however, extend to 5,300 feet. The average annual precipitation is about 105 inches, and the average annual air temperature is about 39 degrees F. The average frost-free period is about 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown very cindery loamy sand 7 inches thick. The upper 4 inches of the subsoil is strong brown very cindery loamy sand. The next 10 inches is strong brown very cindery sand. The lower part to a depth of 60 inches is dark yellowish brown and olive brown very gravelly sandy loam. In some areas the surface layer is extremely cindery or cindery loamy sand. In other areas the soil is 40 to 60 inches deep to andesite or

sandstone, has 15 to 35 percent rock fragments in the substratum, or is 30 to 60 inches deep to dense glacial till.

Included in this unit are small areas of Cotteral soils and Cattcreek soils that have slopes of less than 65 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the upper part of the Cattcreek soil and moderate in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, western white pine, and Alaska cedar. The common forest understory plants are common beargrass, longtube twinflower, western brackenfern, evergreen blackberry, black mountain huckleberry, princes pine, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 124 for western hemlock and is estimated to be 117 for Douglas fir. On the basis of a 50-year site curve, it is 86 for western hemlock and is estimated to be 90 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 188 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting Douglas fir, noble fir, or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and western hemlock occurs periodically. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass VIIe.

29—Cattcreek very cindery loamy sand, sandstone substratum, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes and in cirque basins. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation generally is 2,800 to 4,000 feet. Some areas, however, extend to 5,300 feet. The average annual precipitation is about 105 inches, and the average annual air temperature is about 39 degrees F. The average frost-free period is about 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown very cindery loamy sand 7 inches thick. The upper part of the subsoil is reddish brown and strong brown extremely cindery coarse sand 24 inches thick. The lower part to a depth of 60 inches is dark brown and dark yellowish brown extremely gravelly sandy loam. In some areas the surface layer is extremely cindery loamy sand. In other areas the soil has 15 to 35 percent rock fragments in the substratum, is 30 to 60 inches deep to dense glacial till, or is underlain by andesite or sandstone at a depth of 40 to 60 inches.

Included in this unit are small areas of Cotteral soils and Cattcreek soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the upper part of the

Cattcreek soil and moderate in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, western white pine, and Alaska cedar. The common forest understory plants are common beargrass, longtube twinflower, western brackenfern, evergreen blackberry, black mountain huckleberry, princes pine, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 124 for western hemlock and is estimated to be 117 for Douglas fir. On the basis of a 50-year site curve, it is 86 for western hemlock and is estimated to be 90 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 188 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting Douglas fir, noble fir, or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and western hemlock occurs periodically. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass VIIe.

30—Cattcreek very cindery loamy sand, sandstone substratum, 65 to 90 percent slopes. This very deep, well drained soil is on mountain back slopes and in cirque basins. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation generally is 2,800 to 4,000 feet. Some areas, however, extend to 5,300 feet. The average annual precipitation is about 105 inches, and the average annual air temperature is about 39 degrees F. The average frost-free period is about 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown very cindery loamy sand 7 inches thick. The upper part of the subsoil is reddish brown and strong brown extremely cindery coarse sand 24 inches thick. The lower part to a depth of 60 inches is dark brown and dark yellowish brown extremely gravelly sandy loam. In some areas the surface layer is extremely cindery loamy sand. In other areas the soil has 15 to 35 percent rock fragments in the substratum, is 30 to 60 inches deep to dense glacial till, or is underlain by andesite or sandstone at a depth of 40 to 60 inches.

Included in this unit are small areas of Cotteral and Vailton soils, organic soils in depressions, and Cattcreek soils that have slopes of less than 65 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the upper part of the Cattcreek soil and moderate in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, western white pine, and Alaska cedar. The common forest understory plants are

common beargrass, longtube twinflower, western brackenfern, evergreen blackberry, black mountain huckleberry, princes pine, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 124 for western hemlock and is estimated to be 117 for Douglas fir. On the basis of a 50-year site curve, it is 86 for western hemlock and is estimated to be 90 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 188 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying sandstone. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting Douglas fir, noble fir, or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and western hemlock occurs periodically. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass VIIe.

31—Cattcreek very cindery loamy sand, till substratum, 8 to 30 percent slopes. This deep, well drained soil is on till plains and in cirque basins. It formed in dacitic pumice and volcanic ash, colluvium and slope alluvium derived from andesite and sandstone, and glacial till. The native vegetation is mainly conifers and shrubs. Elevation generally is 2,800 to 4,000 feet. Some areas, however, extend to 5,300 feet. The average annual precipitation is about 105 inches, and the average annual air temperature is about 39 degrees F. The average frost-free period is about 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown and dark reddish brown very cindery loamy sand 8 inches thick. The upper part of the subsoil is strong brown and brownish yellow very cindery sand 9 inches thick. The next 5 inches is dark brown and strong brown very gravelly silt loam. The next 20 inches is dark brown and dark yellowish brown very gravelly loam. The lower part to a depth of 50 inches is dark grayish brown extremely gravelly sandy loam. Very dark grayish brown, dense glacial till that crushes to extremely gravelly sandy loam is below a depth of about 50 inches. The dense glacial till is similar to a cemented pan. The depth to dense glacial till ranges from 40 to 60 inches. In some areas the surface layer is cindery loamy sand. In other areas the soil is more than 60 inches deep to dense glacial till or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Cotteral soils and Cattcreek soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is rapid in the upper part of the Cattcreek soil, moderate in the substratum, and very slow in the dense glacial till. Available water capacity is low. The effective rooting depth is 40 to 60 inches. Water is perched above the dense glacial till from November through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, western white pine, and Alaska cedar. The common forest understory plants are common beargrass, longtube twinflower, western brackenfern, evergreen blackberry, black mountain

huckleberry, princes pine, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 124 for western hemlock and is estimated to be 117 for Douglas fir. On the basis of a 50-year site curve, it is 86 for western hemlock and is estimated to be 90 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 188 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting Douglas fir, noble fir, or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and western hemlock occurs periodically. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass VIe.

32—Cayuse sandy loam, 8 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes and ridge crests. It formed in volcanic ash and pumice over residuum and colluvium derived dominantly from andesite and basalt. The native vegetation is mainly conifers and shrubs. Elevation is 5,000 to 6,200 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 38 degrees F. The average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 0.25 inch thick. The upper 4 inches of the surface layer is very dark grayish brown sandy loam. The lower 9 inches is dark brown sandy loam. The upper 17 inches of the subsoil is brown loam. The lower 6 inches is dark yellowish brown gravelly loam. The substratum to a depth of 60 inches is variegated dark yellowish brown and yellowish brown very gravelly loam. In some areas the surface layer is loamy sand. In other areas the soil has 15 to 35 percent rock fragments in the lower part of the subsoil and the substratum.

Included in this unit are small areas of soils that have more than 35 percent rock fragments throughout. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Cayuse soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are subalpine fir and Engelmann spruce. The common forest understory plants are fawnlily, wild ginger, roughfruit berry, tall blue huckleberry, oneleaf foamflower, bunchberry dogwood, and lambstongue fawnlily.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through June. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft

when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir occurs periodically. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit.

This unit is in capability subclass VIe.

33—Cayuse sandy loam, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes and ridge crests. It formed in volcanic ash and pumice over residuum and colluvium derived dominantly from andesite and basalt. The native vegetation is mainly conifers and shrubs. Elevation is 5,000 to 6,200 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 38 degrees F. The average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 0.25 inch thick. The upper 4 inches of the surface layer is very dark grayish brown sandy loam. The lower 9 inches is dark brown sandy loam. The upper 17 inches of the subsoil is brown loam. The lower 6 inches is dark yellowish brown gravelly loam. The substratum to a depth of 60 inches is variegated dark yellowish brown and yellowish brown very gravelly loam. In some areas the surface layer is loamy sand. In other areas the soil has 15 to 35 percent rock fragments in the lower part of the subsoil and the substratum.

Included in this unit are small areas of soils that have more than 35 percent rock fragments throughout. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Cayuse soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are subalpine fir and Engelmann spruce. The common forest understory plants are fawnlily, wild ginger, roughfruit berry, tall blue huckleberry, oneleaf foamflower, bunchberry dogwood, and lambstongue fawnlily.

On the basis of a 100-year site curve, the mean site index for western hemlock is 77. On the basis of a 50-year site curve, it is 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 84 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through June. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir or western hemlock

seedlings. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir occurs periodically. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit.

This unit is in capability subclass VIIe.

34—Chinkmin sandy loam, 0 to 15 percent slopes. This moderately well drained soil is in cirques, in valleys, and on lateral moraines and drift plains in mountains. It is moderately deep to ortstein. It formed in a thin mantle of volcanic ash or pumice over colluvium derived from dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 6,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown sandy loam. The upper 7 inches of the subsoil is variegated strong brown and reddish brown gravelly loam. The next 7 inches is brown very cobbly loam. The lower part is dark yellowish brown very gravelly sandy loam 10 inches thick. Ortstein is at a depth of about 32 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loamy sand or loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to ortstein, or has a less developed subsoil.

Included in this unit are small areas of Haywire, Nimue, and Serene soils, organic soils in depressions, and Chinkmin soils that have slopes of more than 15 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Chinkmin soil and very slow in the ortstein. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through July. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Alaska cedar, and mountain hemlock. The common forest understory plants are tall blue huckleberry, common beargrass, rusty menziesia, Oregongrape, brackenfern, currant, and Sitka mountainash.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 88. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 102 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, subalpine fir, and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

35—Chinkmin sandy loam, 15 to 30 percent slopes. This moderately well drained soil is in cirques, in valleys, and on lateral moraines and drift plains in mountains. It is moderately deep to ortstein. It formed in a thin mantle of volcanic ash or pumice over colluvium derived from dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 6,000 feet. The average annual precipitation is about 100

inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown sandy loam. The upper 7 inches of the subsoil is variegated strong brown and reddish brown gravelly loam. The next 7 inches is brown very cobbly loam. The lower part is dark yellowish brown very gravelly sandy loam 10 inches thick. Ortstein is at a depth of about 32 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loamy sand or loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to ortstein, or has a less developed subsoil.

Included in this unit are small areas of Haywire, Nimue, and Serene soils, slump areas, organic soils in depressions, and Chinkmin soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Chinkmin soil and very slow in the ortstein. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through July. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Alaska cedar, and mountain hemlock. The common forest understory plants are tall blue huckleberry, common beargrass, rusty menziesia, Oregongrape, brackenfern, currant, and Sitka mountainash.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 88. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 102 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, subalpine fir, and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

36—Chinkmin sandy loam, 30 to 65 percent slopes. This moderately well drained soil is in cirques, in valleys, and on lateral moraines and drift plains in mountains. It is moderately deep to ortstein. It formed in a thin mantle of volcanic ash or pumice over colluvium derived from dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 6,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown sandy loam. The upper 7 inches of the subsoil is variegated strong brown and reddish brown gravelly loam. The next 7 inches is brown very cobbly loam. The lower part is dark yellowish brown very gravelly sandy loam 10 inches thick. Ortstein is at a depth of about 32 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loamy sand or loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to ortstein, or has a less developed subsoil.

Included in this unit are small areas of Haywire, Nimue, and Serene soils, slump areas, organic soils in depressions, and Chinkmin soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Chinkmin soil and very slow in the ortstein. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through July. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Alaska cedar, and mountain hemlock. The common forest understory plants are tall blue huckleberry, common beargrass, rusty menziesia, Oregongrape, brackenfern, currant, and Sitka mountainash.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 88. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 102 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, subalpine fir, and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

37—Chinkmin sandy loam, cold, 0 to 15 percent slopes. This moderately well drained soil is in cirques, in valleys, and on lateral moraines and drift plains in mountains. It is moderately deep to ortstein. It formed in a thin mantle of volcanic ash or pumice over colluvium derived from dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 4,500 to 6,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown sandy loam. The upper 7 inches of the subsoil is variegated strong brown and reddish brown gravelly loam. The next 7 inches is brown very cobbly loam. The lower part is dark yellowish brown very gravelly sandy loam 10 inches thick. Ortstein is at a depth of about 32 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loamy sand or loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to ortstein, or has a less developed subsoil.

Included in this unit are small areas of Haywire, Nimue, and Serene soils, organic soils in depressions, and Chinkmin soils that have slopes of more than 15 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Chinkmin soil and very slow in the ortstein. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from

November through July. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Alaska cedar, and mountain hemlock. The common forest understory plants are tall blue huckleberry, common beargrass, rusty menziesia, Oregongrape, brackenfern, currant, and Sitka mountainash.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 81. On the basis of a 50-year site curve, it is estimated to be 60. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 90 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through June. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by subalpine fir and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

38—Chinkmin sandy loam, cold, 15 to 30 percent slopes. This moderately well drained soil is in cirques, in valleys, and on lateral moraines and drift plains in mountains. It is moderately deep to ortstein. It formed in a thin mantle of volcanic ash or pumice over colluvium derived from dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 4,500 to 6,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown sandy loam. The upper 7 inches of the subsoil is variegated strong brown and reddish brown gravelly loam. The next 7 inches is brown very cobbly loam. The lower part is dark yellowish brown very gravelly sandy loam 10 inches thick. Ortstein is at a depth of about 32 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loamy sand or loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to ortstein, or has a less developed subsoil.

Included in this unit are small areas of Haywire, Nimue, and Serene soils, slump areas, organic soils in depressions, and Chinkmin soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Chinkmin soil and very slow in the ortstein. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through July. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Alaska cedar, and mountain hemlock. The common forest understory plants are tall blue huckleberry, common beargrass, rusty menziesia, Oregongrape, brackenfern, currant, and Sitka mountainash.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 81. On the basis of a 50-year site curve, it is estimated to be 60. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 90 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through June. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by subalpine fir and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

39—Christoff sandy loam, 6 to 30 percent slopes. This very deep, moderately well drained soil is on mountain side slopes and in slump areas. It formed in volcanic ash and cinders over weathered breccia and tuffaceous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 6 inches, the surface layer is brown sandy loam. The upper 6 inches of the subsurface layer also is brown sandy loam. The lower 14 inches is dark yellowish brown loam. The upper 16 inches of the subsoil also is dark yellowish brown loam. The lower part to a depth of 60 inches is brown clay loam. In some areas the surface layer is loam or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in part of the subsoil.

Included in this unit are small areas of Littlejohn, Ogarty, and Pitcher soils, poorly drained mineral soils in depressions, and Christoff soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Christoff soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 2.5 to 4.0 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are western swordfern, Oregongrape, salal, red huckleberry, trillium, creambush oceanspray, vine maple, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 143. On the basis of a 50-year site curve, it is 106. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished

by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

40—Christoff sandy loam, 30 to 65 percent slopes. This very deep, moderately well drained soil is on mountain side slopes and in slump areas. It formed in volcanic ash and cinders over weathered breccia and tuffaceous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 6 inches, the surface layer is brown sandy loam. The upper 6 inches of the subsurface layer also is brown sandy loam. The lower 14 inches is dark yellowish brown loam. The upper 16 inches of the subsoil also is dark yellowish brown loam. The lower part to a depth of 60 inches is brown clay loam. In some areas the surface layer is loam or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in part of the subsoil.

Included in this unit are small areas of Littlejohn, Ogarty, and Pitcher soils and Christoff soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Christoff soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 2.5 to 4.0 feet from December through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are western swordfern, Oregongrape, salal, red huckleberry, trillium, creambush oceanspray, vine maple, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 143. On the basis of a 50-year site curve, it is 106. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

41—Chuckanut loam, 6 to 15 percent slopes. This deep, well drained soil is on toe slopes in the foothills. It formed in a mixture of volcanic ash and colluvium derived from sandstone and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 1,500 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 49 degrees F. The average frost-free period is about 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown loam 8 inches thick. The upper 9 inches of the subsoil is dark yellowish brown gravelly

loam. The next 18 inches is pale brown gravelly sandy loam and dark brown gravelly loam. The lower 10 inches is light brownish gray gravelly loam. The substratum is light gray gravelly sandy loam 5 inches thick. Sandstone is at a depth of about 50 inches. The depth to sandstone ranges from 40 to 60 inches. In some areas the surface layer is gravelly loam or sandy loam. In other areas the soil has a nongravelly subsoil or is more than 60 inches deep to sandstone.

Included in this unit are small areas of Alderwood, Beausite, and Tokul soils, soils that are 20 to 40 inches deep to sandstone, and Chuckanut soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Chuckanut soil. Available water capacity is moderate or high. The effective rooting depth is 40 to 60 inches. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used for pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used mainly as woodland. It also is suitable as pasture and hayland.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, western brackenfern, western swordfern, Oregongrape, red huckleberry, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 171. On the basis of a 50-year site curve, it is 128. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 182 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

42—Chuckanut loam, 15 to 30 percent slopes. This deep, well drained soil is on toe slopes and back slopes in the foothills. It formed in a mixture of volcanic ash and colluvium derived from sandstone and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 1,500 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 49 degrees F. The average frost-free period is about 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown loam 8 inches thick. The upper 9 inches of the subsoil is dark yellowish brown gravelly loam. The next 18 inches is pale brown gravelly sandy loam and dark brown gravelly loam. The lower 10 inches is light brownish gray gravelly loam. The substratum is light gray gravelly loam 5 inches thick. Sandstone is at a depth of about 50 inches. The depth to sandstone ranges from 40 to 60 inches. In some areas the surface layer is gravelly loam or sandy loam. In other areas the soil has a nongravelly subsoil or is more than 60 inches deep to sandstone.

Included in this unit are small areas of Alderwood, Beausite, and Tokul soils, soils that are 20 to 40 inches deep to sandstone, and Chuckanut soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Chuckanut soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, western brackenfern, western swordfern, Oregongrape, red huckleberry, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 171. On the basis of a 50-year site curve, it is 128. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 182 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet

causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

43—Chuckanut loam, 30 to 65 percent slopes. This deep, well drained soil is on back slopes in the foothills. It formed in a mixture of volcanic ash and colluvium derived from sandstone and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 1,500 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 49 degrees F. The average frost-free period is about 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown loam 8 inches thick. The upper 9 inches of the subsoil is dark yellowish brown gravelly loam. The next 18 inches is pale brown gravelly sandy loam and dark brown gravelly loam. The lower 10 inches is light brownish gray gravelly loam. The substratum is light gray gravelly loam 5 inches thick. Sandstone is at a depth of about 50 inches. The depth to sandstone ranges from 40 to 60 inches. In some areas the surface layer is gravelly loam or sandy loam. In other areas the soil has a nongravelly subsoil or is more than 60 inches deep to sandstone.

Included in this unit are small areas of Alderwood, Beausite, and Tokul soils, soils that are 20 to 40 inches deep to sandstone, and Chuckanut soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Chuckanut soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, western brackenfern, western swordfern, Oregongrape, red huckleberry, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 171. On the basis of a 50-year site curve, it is 128. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 182 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

44—Cinebar silt loam, 6 to 15 percent slopes. This very deep, well drained soil is on toe slopes in the foothills. It formed in loess and slope alluvium high in content of volcanic ash. The native vegetation is mainly

conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 175 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and moss 2 inches thick. The surface layer is dark brown silt loam 10 inches thick. The next 8 inches also is dark brown silt loam. The subsoil is yellowish brown silt loam 36 inches thick. The substratum to a depth of 60 inches is yellowish brown loam. In some areas the surface layer is loam. In other areas the soil has strata of sandy material in the subsoil.

Included in this unit are small areas of Klaber, Mashel, Scamman, and Wilkeson soils and Cinebar soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Cinebar soil. Available water capacity is high. The effective rooting depth is 60 inches. In most areas, runoff is slow and the hazard of water erosion is slight. In the areas used as pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used as woodland. It also is suitable as pasture and hayland.

Douglas fir, red alder, and western hemlock are the main woodland species. Among the trees of limited extent are bigleaf maple and western redcedar. The common forest understory plants are western swordfern, Oregongrape, red huckleberry, salal, trillium, devilsclub, vine maple, and oxalis.

On the basis of a 100-year site curve, the mean site index is 174 for Douglas fir and 155 for western hemlock. On the basis of a 50-year site curve, it is 132 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 185 cubic feet per acre per year, occurring at age 60. For western hemlock it is 246 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of red alder have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

45—Cinebar silt loam, 15 to 30 percent slopes. This very deep, well drained soil is on toe slopes in the foothills. It formed in loess and slope alluvium high in content of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 175 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and moss 2 inches thick. The surface layer is dark brown silt loam 10 inches thick. The next 8 inches also is dark brown silt loam. The subsoil is yellowish brown silt loam 36 inches thick. The substratum to a depth of 60 inches is yellowish brown loam. In some areas the surface layer is loam. In other areas the soil has strata of sandy material in the subsoil.

Included in this unit are small areas of Mashel, Scamman, and Wilkeson soils and Cinebar soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Cinebar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir, red alder, and western hemlock are the main woodland species. Among the trees of limited extent are bigleaf maple and western redcedar. The common forest understory plants are western swordfern, Oregongrape, red huckleberry, salal, trillium, devilsclub, vine maple, and oxalis.

On the basis of a 100-year site curve, the mean site

index is 174 for Douglas fir and 155 for western hemlock. On the basis of a 50-year site curve, it is 132 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 185 cubic feet per acre per year, occurring at age 60. For western hemlock it is 246 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of red alder have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

46—Cinebar silt loam, 30 to 45 percent slopes. This very deep, well drained soil is on back slopes in the foothills. It formed in loess and slope alluvium high in content of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 175 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and moss 2 inches thick. The surface layer is dark brown silt loam 10 inches thick. The next 8 inches also is dark brown silt loam. The subsoil is yellowish brown silt loam 36 inches thick. The substratum to a depth of 60 inches is yellowish brown loam. In some areas the surface layer is loam. In other areas the soil has strata of sandy material in the subsoil.

Included in this unit are small areas of Mashel, Scamman, and Wilkeson soils and Cinebar soils that have slopes of more than 45 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Cinebar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir, red alder, and western hemlock are the main woodland species. Among the trees of limited extent are bigleaf maple and western redcedar. The common forest understory plants are western swordfern, Oregongrape, red huckleberry, salal, trillium, devilsclub, vine maple, and oxalis.

On the basis of a 100-year site curve, the mean site index is 174 for Douglas fir and 155 for western hemlock. On the basis of a 50-year site curve, it is 132 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 185 cubic feet per acre per year, occurring at age 60. For western hemlock it is 246 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of red alder have not been made.

The main limitation affecting timber harvesting is the slope. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Establishing a plant cover in these disturbed areas reduces the hazard of erosion.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective

plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

47—Cotteral very cindery sandy loam, 8 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes and ridges. It formed in volcanic ash and weathered cinders. The native vegetation is mainly conifers and shrubs. Elevation is 2,800 to 3,600 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 125 days.

Typically, the surface is covered with a mat of needles, twigs, moss, and rotted wood 3 inches thick. When mixed to a depth of 9 inches, the surface layer is reddish brown very cindery sandy loam. The upper part of the subsoil is dark brown and strong brown very cindery sand 23 inches thick. The lower part to a depth of 60 inches is dark yellowish brown silt loam. In some areas the surface layer is very cindery loamy sand or cindery sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 20 to 60 inches deep to dense glacial till, or is 40 to 60 inches deep to sandstone or andesite.

Included in this unit are small areas of Cattcreek and Ethania soils and Cotteral soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Cotteral soil. Available water capacity is moderate or high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are western redcedar, noble fir, Alaska cedar, and western white pine. The common forest understory plants are western swordfern, vine maple, Oregongrape, red huckleberry, western brackenfern, and common beargrass.

On the basis of a 100-year site curve, the mean site index is estimated to be 120 for western hemlock and 117 for Douglas fir. On the basis of a 50-year site curve, it is estimated to be 85 for western hemlock and 90 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 180 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting Douglas fir, noble fir, western hemlock, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass VIe.

48—Cotteral very cindery sandy loam, cold, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes and ridges. It formed in volcanic ash and weathered cinders. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 4,900 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 125 days.

Typically, the surface is covered with a mat of needles, twigs, moss, and rotted wood 3 inches thick. When mixed to a depth of 6 inches, the surface layer is reddish brown very cindery sandy loam. The upper 8 inches of the subsoil is strong brown very cindery loamy sand. The next 5 inches is dark reddish brown and dark yellowish brown sandy loam. The lower part to a depth of 60 inches is light olive brown sandy loam. In some areas the surface layer is very cindery loamy sand or cindery sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 20 to 60 inches deep to dense glacial till, or is 40 to 60 inches deep to sandstone.

Included in this unit are small areas of Cattcreek and Ethania soils and Cotteral soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Cotteral soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are western redcedar and noble fir. The common forest understory plants are western swordfern, vine maple, Oregongrape, red huckleberry, western brackenfern, and common beargrass.

On the basis of a 100-year site curve, the mean site index for western hemlock is 88. On the basis of a 50-year site curve, it is 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 102 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir, western hemlock, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass VIIe.

49—Crinker very channery loam, 30 to 65 percent slopes. This well drained soil is on glacially modified mountain back slopes and shoulder slopes. It is moderately deep to weathered bedrock. It formed in a mixture of glacial till, volcanic ash, and colluvium and slope alluvium derived dominantly from phyllite. The colluvium is modified slightly by glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of decomposed needles, leaves, and twigs 5 inches thick. When mixed to a depth of 5 inches, the surface layer is

dark brown very channery loam. The subsoil is dark yellowish brown extremely channery loam 17 inches thick. The substratum is dark grayish brown extremely channery loam 10 inches thick. Phyllite is at a depth of about 32 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is channery silt loam or channery loam. In other areas the soil has a less developed subsoil or is 14 to 20 or 40 to 60 inches deep to phyllite.

Included in this unit are small areas of Altapeak, Hinker, Klapatche, Playco, and Serene soils, soils that are 20 to 40 inches deep to dense glacial till, Rock outcrop, and Crinker soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the Crinker soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent is Pacific silver fir. The common forest understory plants are tall blue huckleberry, salmonberry, bunchberry dogwood, western brackenfern, and deer fern.

On the basis of a 100-year site curve, the mean site index for western hemlock is 119. On the basis of a 50-year site curve, it is 83. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 178 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality phyllite. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock, noble fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

50—Cryofluvents, 0 to 8 percent slopes. These deep, well drained soils are in mountain valleys. They formed in alluvium over andesite. The native vegetation is mainly conifers and shrubs. Elevation is 2,800 to 3,500 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 38 degrees F. The average frost-free period is about 100 days.

No single profile is representative of these soils. One of the more commonly observed ones, however, is covered with a mat of needles, leaves, and twigs about 4 inches thick. Typically, the surface layer is dark brown stony sandy loam 5 inches thick. The subsoil is dark yellowish brown gravelly loamy sand 4 inches thick. The upper 19 inches of the substratum is dark yellowish brown gravelly loamy sand and dark brown very gravelly loamy sand. The lower 21 inches is light olive brown very gravelly fine sand. Andesite is at a depth of about 49 inches. The depth to andesite ranges from 40 to 80 inches. The distribution of organic carbon varies with increasing depth. The subsoil and substratum are sandy or are sandy and stratified with grayish, low-

chroma, silty material. The content of rock fragments in the control section ranges from 25 to 45 percent by weighted average.

Included in this unit are small areas of organic soils. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the Cryofluvents. Available water capacity is low. The effective rooting depth is more than 40 inches. Runoff is slow, and the hazard of water erosion is slight. The soils are subject to occasional, brief periods of flooding from December through May.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, Douglas fir, and Alaska cedar. The common forest understory plants are huckleberry, princes pine, bunchberry dogwood, deer fern, and lupine.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 110. On the basis of a 50-year site curve, it is estimated to be 80. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 161 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soils are moist and a moderate degree of puddling when the soils are wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir occurs readily.

This unit is in capability subclass VIw.

51—Cryohemists, 0 to 2 percent slopes. These very deep, very poorly drained soils are in depressions in mountain valleys and in cirques on mountains. They formed in a mixture of peat, muck, pumice, volcanic ash, and glacial till. The native vegetation is mainly shrubs and sedges. Elevation is 2,800 to 3,500 feet. The average annual precipitation is about 105 inches, and the average annual air temperature is about 41 degrees F. The average frost-free period is about 110 days.

No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface layer is black muck about 6 inches thick. The upper 15 inches of the underlying material is very dark grayish brown hemic material. The next 7 inches is dark brown hemic material. The lower part to a depth of 60 inches is gray clay loam. The depth to mineral soil material ranges from 20 to more than 60 inches. After rubbing, the overall content of fiber ranges from 20 to 30 percent, although individual layers can have as much as 50 percent. Reaction is extremely acid or very strongly acid.

Included in this unit are small areas of ponded mineral soils. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Cryohemists. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at or above the surface from November through June. Runoff is ponded, and there is no hazard of erosion.

This unit is used for wildlife habitat. The native vegetation consists of sedges, willows, skunk cabbage, deer fern, and huckleberry.

This unit is in capability subclass VIIw.

52—Dobbs loam, 8 to 30 percent slopes. This moderately well drained soil is in cirque basins and on the adjacent mountain back slopes. It is moderately deep to dense glacial till. It formed in glacial till, volcanic ash, and colluvium. The native vegetation is mainly conifers and shrubs. Elevation is 2,000 to 3,200 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown loam 10 inches thick. The upper 18

inches of the subsoil is dark brown and dark yellowish brown very gravelly loam. The lower part is yellowish brown very gravelly loam 7 inches thick. Dark yellowish brown, dense glacial till that crushes to very gravelly sandy loam is below a depth of about 35 inches. The dense glacial till is similar to a cemented pan. The depth to dense glacial till ranges from 30 to 40 inches. In some areas the surface layer is gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or is 40 to 60 inches deep to dense glacial till.

Included in this unit are small areas of Jonas, Littlejohn, Pheeney, and Pitcher soils and Dobbs soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Dobbs soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 30 to 40 inches. Water is perched above the dense glacial till from November through March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are Pacific silver fir and noble fir. The common forest understory plants are vine maple, Oregongrape, trailing blackberry, western swordfern, deer fern, and salal.

On the basis of a 100-year site curve, the mean site index is estimated to be 144 for Douglas fir and 140 for western hemlock. On the basis of a 50-year site curve, it is estimated to be 110 for Douglas fir and 100 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 150 cubic feet per acre per year, occurring at age 60. For western hemlock it is about 218 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock, Douglas fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

53—Edgewick silt loam, 0 to 3 percent slopes. This very deep, well drained soil is on river terraces. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is 50 to 500 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 150 days.

Typically, the surface layer is very dark brown silt loam 8 inches thick. The subsoil is olive brown silt loam 12 inches thick. The upper 13 inches of the substratum is olive brown fine sandy loam. The next 13 inches is olive brown loamy sand. The lower part to a depth of 60 inches is dark grayish brown very gravelly sand. In some areas the surface layer is very fine sandy loam, loam, or fine sandy loam. In other areas, the soil is 20 to 40 inches deep to sand or the underlying material is stratified silt loam, fine sandy loam, and sand.

Included in this unit are small areas of Nooksack, Oridia, Salal, and Si soils. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Edgewick soil. Available water capacity also is moderate. The effective rooting depth is limited by a perched high water table, which is at a depth of 3 to 4 feet from February through April. This soil is subject to occasional, brief periods of flooding from November through March. Channeling and deposition are common along streambanks.

This unit is used for pasture, hay, and woodland. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the

pasture in good condition and help to control runoff and erosion. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. If irrigated, this unit is suited to all of the crops commonly grown in the survey area.

Douglas fir and red alder are the main woodland species. Among the trees of limited extent is western redcedar. The common forest understory plants are trailing blackberry, salmonberry, western swordfern, red elderberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 167. On the basis of a 50-year site curve, it is estimated to be 125. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 178 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of red alder have not been made.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and occasional flooding. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. The seedling survival rate may be low where flooding occurs.

This unit is in capability subclass IIIw.

54—Elwell silt loam, 6 to 30 percent slopes. This moderately well drained soil is on mountain back slopes and plateaus. It is moderately deep to ortstein. It formed in glacial till that has an admixture of volcanic ash and loess. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,500 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark yellowish brown silt loam 8 inches thick. The upper 8 inches of the subsoil also is dark yellowish brown silt loam. The lower 19 inches is dark brown and yellowish brown gravelly silt loam. Ortstein that crushes to gravelly silt loam is at a depth of about 35 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam, gravelly loam, or gravelly silt loam. In other areas the soil has 35 to 50 percent rock fragments in the subsoil or is 40 to 60 inches deep to ortstein.

Included in this unit are small areas of Blethen, Skykomish, and Welcome soils and Elwell soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Elwell soil and very slow in the ortstein. Available water capacity is high. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, red huckleberry, western brackenfern, salal, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index is 149 for western hemlock and 165 for Douglas fir. On the basis of a 50-year site curve, it is 105 for western hemlock and 124 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 236 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 176 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully

laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock, Douglas fir, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

55—Elwell silt loam, 30 to 65 percent slopes. This moderately well drained soil is on mountain back slopes and plateaus. It is moderately deep to ortstein. It formed in glacial till with an admixture of volcanic ash and loess. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,500 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark yellowish brown silt loam 8 inches thick. The upper 8 inches of the subsoil also is dark yellowish brown silt loam. The lower 19 inches is dark brown and yellowish brown gravelly silt loam. Ortstein that crushes to gravelly silt loam is at a depth of 35 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam, gravelly loam, or gravelly silt loam. In other areas the soil has 35 to 50 percent rock fragments in the subsoil or is 40 to 60 inches deep to ortstein.

Included in this unit are small areas of Blethen, Skykomish, and Welcome soils and Elwell soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Elwell soil and very slow in the ortstein. Available water capacity is high. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through June. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, red huckleberry, western brackenfern, salal, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index is 149 for western hemlock and 165 for Douglas fir. On the basis of a 50-year site curve, it is 105 for western hemlock and 124 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 236 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 176 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock, Douglas fir, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

56—Ethania very cindery loamy sand, 30 to 65 percent slopes. This very deep, well drained soil is on mountain ridge crests, on back slopes, and in cirque basins. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 5,200 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 37 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 3 inches thick. When mixed to a depth of 7 inches, the surface layer is reddish brown very cindery loamy sand. The upper 24 inches of the subsoil is strong brown and yellowish red very cindery loamy sand. The lower part to a depth of 60 inches is dark brown very gravelly loam. In some areas the surface layer is very cindery sandy loam. In other areas the soil is 40 to 60 inches deep to andesite or sandstone or has 15 to 35 percent rock fragments in the substratum.

Included in this unit are small areas of Cotteral soils, soils that are 20 to 40 inches deep to andesite, and Ethania soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is very rapid in the upper part of the Ethania soil and moderate in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are common beargrass, deer fern, common fireweed, huckleberry, pearly everlasting, and thimbleberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 95. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 113 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir, western hemlock, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and noble fir occurs periodically. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit.

This unit is in capability subclass VIIe.

57—Ethania very cindery loamy sand, 65 to 90 percent slopes. This very deep, well drained soil is on mountain ridge crests, on back slopes, and in cirque basins. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 5,200 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 37 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 3 inches thick. When mixed to a depth of 7 inches, the surface layer is reddish brown very cindery loamy sand. The upper 24 inches of the subsoil is strong brown and yellowish red very cindery loamy sand. The lower part to a depth of 60 inches is dark brown very gravelly loam. In some areas the

surface layer is very cindery sandy loam. In other areas the soil is 40 to 60 inches deep to andesite or sandstone or has 15 to 35 percent rock fragments in the substratum.

Included in this unit are small areas of Cotteral soils, soils that are 20 to 40 inches deep to andesite, and Ethania soils that have slopes of less than 65 percent. Included areas make up about 15 percent of the total acreage.

Permeability is very rapid in the upper part of the Ethania soil and moderate in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are common beargrass, deer fern, common fireweed, huckleberry, pearly everlasting, and thimbleberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 95. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 113 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting noble fir, western hemlock, or Pacific silver fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and noble fir occurs periodically.

This unit is in capability subclass VIIe.

58—Ethania very cindery loamy sand, sandstone substratum, 30 to 65 percent slopes. This very deep, well drained soil is on mountain ridge crests, on back slopes, and in cirque basins. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 5,200 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 37 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 1 inch thick. When mixed to a depth of 6 inches, the surface layer is reddish brown very cindery loamy sand. The upper 8 inches of the subsoil is strong brown very cindery loamy sand. The next 22 inches is dark yellowish brown very gravelly loam and very gravelly sandy loam. The lower part to a depth of 60 inches is olive brown extremely cobbly loamy sand. In some areas the surface layer is very cindery sandy loam. In other areas the soil is 40 to 60 inches deep to sandstone or andesite or has 15 to 35 percent rock fragments in the substratum.

Included in this unit are small areas of Cotteral soils, soils that are 20 to 40 inches deep to sandstone, and Ethania soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Ethania soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium,

and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are common beargrass, deer fern, common fireweed, huckleberry, pearly everlasting, and thimbleberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 95. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 113 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting noble fir, western hemlock, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and noble fir occurs periodically.

This unit is in capability subclass VIIe.

59—Ethania very cindery loamy sand, sandstone substratum, 65 to 90 percent slopes. This very deep, well drained soil is on mountain ridge crests, on back slopes, and in cirque basins. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 5,200 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 37 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 1 inch thick. When mixed to a depth of 6 inches, the surface layer is reddish brown very cindery loamy sand. The upper 8 inches of the subsoil is strong brown very cindery loamy sand. The next 22 inches is dark yellowish brown very gravelly loam and very gravelly sandy loam. The lower part to a depth of 60 inches is olive brown extremely cobbly loamy sand. In some areas the surface layer is very cindery sandy loam. In other areas the soil is 40 to 60 inches deep to sandstone or andesite or has 15 to 35 percent rock fragments in the substratum.

Included in this unit are small areas of Cotteral soils, soils that are 20 to 40 inches deep to sandstone, and Ethania soils that have slopes of less than 65 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Ethania soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are common beargrass, deer fern, common fireweed, huckleberry, pearly everlasting, and thimbleberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 95. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 113 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not

been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting noble fir, western hemlock, or Pacific silver fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and noble fir occurs periodically.

This unit is in capability subclass VIIe.

60—Ethania very cindery loamy sand, till substratum, 8 to 30 percent slopes. This deep, well drained soil is on mountain crests, on back slopes, and in cirques basins. It formed in dacitic pumice and volcanic ash over colluvium and slope alluvium derived from glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 5,200 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 37 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. When mixed to a depth of 8 inches, the surface layer is reddish brown very cindery loamy sand. The upper 7 inches of the subsoil is strong brown very cindery coarse sand. The lower 26 inches is yellowish red and dark brown very gravelly loam. Dark yellowish brown, dense glacial till that crushes to very gravelly loam is at a depth of 41 inches. The dense glacial till is similar to a cemented pan. The depth to dense glacial till ranges from 40 to 60 inches. In some areas the surface layer is cindery loamy sand. In other areas the soil is more than 60 inches deep to dense glacial till or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Cotteral soils, soils that are 20 to 40 inches deep to dense glacial till or bedrock, and Ethania soils that have slopes of more than 30 percent or less than 8 percent.

Permeability is moderate in the Ethania soil. Available water capacity also is moderate. The effective rooting depth is 40 to 60 inches. Water is perched above the dense glacial till from November through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are common beargrass, deer fern, common fireweed, huckleberry, pearly everlasting, and thimbleberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 95. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 113 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer

after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productively can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir, western hemlock, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and noble fir occurs periodically.

This unit is in capability subclass VIs.

61—Foss stony sandy loam, 8 to 30 percent slopes. This very deep, well drained soil is on the interior side slopes of cirque basins, on broad ridge crests, and on benches. It formed in volcanic ash and pumice over residuum and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 3,000 to 5,000 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface layer is very dark brown stony sandy loam 4 inches thick. The upper 12 inches of the subsoil is yellowish brown and strong brown gravelly sandy loam. The next 32 inches is dark brown very cobbly silt loam and dark reddish brown very gravelly silt loam. The lower part to a depth of 60 inches is dark reddish brown very gravelly silt loam. In some areas the surface layer is gravelly loam or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the lower part of the subsoil and in the substratum.

Included in this unit are small areas of Haywire and Nagrom soils and Foss soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Foss soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Douglas fir. The common forest understory plants are common beargrass, evergreen huckleberry, western rattlesnake plantain, princes pine, and queencup beadlily.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 95. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 113 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack and the stones on the surface. The stones can hinder yarding. When felled, the timber can break on the stones. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality and establishment are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are

subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting noble fir or western hemlock seedlings. Because of the stones on the surface, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIe.

62—Foss stony sandy loam, 30 to 65 percent slopes. This very deep, well drained soil is on the interior back slopes of cirque basins, on broad ridge crests, and on benches. It formed in volcanic ash and pumice over residuum and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 3,000 to 5,000 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface layer is very dark brown stony sandy loam 4 inches thick. The upper 12 inches of the subsoil is yellowish brown and strong brown gravelly sandy loam. The next 32 inches is dark brown very cobbly silt loam and dark reddish brown very gravelly silt loam. The lower part to a depth of 60 inches is dark reddish brown very gravelly silt loam. In some areas the surface layer is gravelly loam or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the lower part of the subsoil and in the substratum.

Included in this unit are small areas of Haywire and Nagrom soils and Foss soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Foss soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Douglas fir. The common forest understory plants are common beargrass, evergreen huckleberry, western rattlesnake plantain, princes pine, and queencup beadlily.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 95. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 113 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, the stones on the surface, and the hazard of erosion. The stones can hinder yarding. When felled, the timber can break on the stones. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality and establishment are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting noble fir or western hemlock seedlings. Because of the stones on the surface, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

63—Gallup loam, 6 to 30 percent slopes. This very deep, well drained soil is on glacially modified mountain ridgetops and back slopes. It formed in volcanic ash and weathered metasediments. The native vegetation is mainly conifers and shrubs. Elevation is 2,700 to 3,600 feet. The average annual precipitation is about 95 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of decomposed needles, leaves, and twigs 2 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown loam. The upper 9 inches of the subsoil is strong brown gravelly loam. The lower 27 inches is yellowish brown and brownish yellow gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown gravelly loam. In some areas the surface layer is sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil.

Included in this unit are small areas of Chinkmin, Haywire, Nagrom, Nimue, and Playco soils and Gallup soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Gallup soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is Douglas fir. The common forest understory plants are deer fern, huckleberry, common beargrass, and salal.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 101. On the basis of a 50-year site curve, it is estimated to be 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and establishment are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of western hemlock seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIs.

64—Gallup loam, 30 to 65 percent slopes. This very deep, well drained soil is on glacially modified mountain ridgetops and back slopes. It formed in volcanic ash and weathered metasediments. The native vegetation is mainly conifers and shrubs. Elevation is 2,700 to 3,600 feet. The average annual precipitation is about 95 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of decomposed needles, leaves, and twigs 2 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown loam. The upper 9 inches of the subsoil is strong brown gravelly loam. The lower 27 inches is yellowish brown and brownish yellow gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown gravelly loam. In some areas the surface layer is sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil.

Included in this unit are small areas of Chinkmin, Haywire, Nagrom, and Nimue soils and Gallup soils that

have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Gallup soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is Douglas fir. The common forest understory plants are deer fern, huckleberry, common beargrass, and salal.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 101. On the basis of a 50-year site curve, it is estimated to be 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality and establishment are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of western hemlock seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

65—Gallup loam, breccia substratum, 30 to 65 percent slopes. This very deep, well drained soil is on glacially modified mountain ridgetops and shoulder slopes. It formed in volcanic ash and in colluvium derived dominantly from volcanic breccia. The native vegetation is mainly conifers and shrubs. Elevation is 2,800 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown loam. The upper 8 inches of the subsoil also is dark reddish brown loam. The next 8 inches is dark brown loam. The lower 13 inches is dark yellowish brown gravelly loam. The upper 13 inches of the substratum is dark yellowish brown gravelly sandy loam. The lower part to a depth of 60 inches is dark yellowish brown gravelly loam. In some areas the surface layer is silt loam.

Included in this unit are small areas of Hartnit, Klapatche, Nagrom, Playco, and Stahl soils, soils that have 35 to 60 percent rock fragments throughout, and Gallup soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Gallup soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is Douglas fir. The common forest understory plants are red huckleberry, blueleaved huckleberry, bunchberry dogwood, trailing blackberry, deer fern, longtube twinflower, Oregongrape, vine maple, and salal.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 101. On the basis of a 50-year site curve, it is estimated to be

75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. In areas that have slopes of less than 30 percent, wheeled and tracked equipment can be used. If this equipment is used when the soil is wet, excessive rutting can result. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality and establishment are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

66—Getchell loam, 6 to 15 percent slopes. This moderately well drained soil is on glacially modified mountain back slopes and plateaus. It is moderately deep to ortstein. It formed in volcanic ash, colluvium, and dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles and twigs 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown loam. The upper 5 inches of the subsoil also is dark reddish brown loam. The next 7 inches is dark brown loam. The lower 11 inches is light yellowish brown gravelly loam. Light olive brown ortstein is at a depth of about 30 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is silt loam, sandy loam, or gravelly loam. In other areas the soil has a gravelly subsoil, is 40 to 60 inches deep to ortstein, has more than 6 percent organic carbon in the upper part of the subsoil, or has a less developed subsoil.

Included in this unit are small areas of Chinkmin, Hartnit, Kindy, and Playco soils, soils that are less than 20 inches deep to dense glacial till, poorly drained soils in depressions, and Getchell soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Getchell soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. The common forest understory plants are red huckleberry, deer fern, western brackenfern, devilsclub, ladyfern, and bunchberry dogwood.

On the basis of a 100-year site curve, the mean site index for western hemlock is 129. On the basis of a 50-year site curve, it is 91. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 198 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from December through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock, Douglas fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

67—Getchell loam, 15 to 30 percent slopes. This moderately well drained soil is on glacially modified mountain back slopes and plateaus. It is moderately deep to ortstein. It formed in volcanic ash, colluvium, and dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles and twigs 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark gray and black loam. The upper 5 inches of the subsoil is dark reddish brown loam. The next 7 inches is dark brown loam. The lower 11 inches is light yellowish brown gravelly loam. Light olive brown ortstein is at a depth of about 30 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is silt loam, sandy loam, or gravelly loam. In other areas the soil has a gravelly subsoil, is 40 to 60 inches deep to ortstein, has more than 6 percent organic carbon in the upper part of the subsoil, or has a less developed subsoil.

Included in this unit are small areas of Chinkmin, Hartnit, Kindy, and Playco soils, soils that are less than 20 inches deep to dense glacial till, and Getchell soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Getchell soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. The common forest understory plants are red huckleberry, deer fern, western brackenfern, devilsclub, ladyfern, and bunchberry dogwood.

On the basis of a 100-year site curve, the mean site index for western hemlock is 129. On the basis of a 50-year site curve, it is 91. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 198 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from December through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock, Douglas fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

68—Getchell loam, 30 to 65 percent slopes. This moderately well drained soil is on glacially modified mountain back slopes and plateaus. It is moderately deep to ortstein. It formed in volcanic ash, colluvium, and dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles and twigs 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark gray and black loam. The upper 5 inches of the subsoil is dark reddish brown loam. The next 7 inches is dark brown loam. The lower 11 inches is light yellowish brown gravelly loam. Light olive brown ortstein is at a depth of about 30 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is silt loam, sandy loam, or gravelly loam. In other areas the soil has a gravelly subsoil, is 40 to 60 inches deep to ortstein, has more than 6 percent organic carbon in the upper part of the subsoil, or has a less developed subsoil.

Included in this unit are small areas of Chinkmin, Hartnit, Kindy, and Playco soils, soils that are less than 20 inches deep to dense glacial till, and Getchell soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Getchell soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. The common forest understory plants are red huckleberry, deer fern, western brackenfern, devilsclub, ladyfern, and bunchberry dogwood.

On the basis of a 100-year site curve, the mean site index for western hemlock is 129. On the basis of a 50-year site curve, it is 91. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 198 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from December through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock, Douglas fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

69—Greenwater loamy sand, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in alluvium derived dominantly from pumice and andesite. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 49 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of needles, twigs, leaves, and moss 3 inches thick. The surface layer is very dark brown loamy sand 5 inches thick. The subsoil is dark brown loamy sand 12 inches thick. The upper 34 inches of the substratum is dark grayish brown sand and dark gray sand and coarse sand. The lower part to a depth of 60 inches is dark gray very gravelly coarse sand. In some areas the soil has 0 to 35 percent rock fragments in the lower part of the substratum or does not have pumice.

Included in this unit are small areas of Grotto, Snoqualmie, and Winston soils and Greenwater soils that have slopes of more than 8 percent. Included areas make up about 20 percent of the total acreage.

Permeability is rapid in the Greenwater soil. Available water capacity is low. The effective rooting depth is 60 inches or more. This soil is subject to rare flooding. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used as pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used as woodland. If irrigated, it also is suitable as pasture and hayland.

Douglas fir, western hemlock, and red alder are the main woodland species. Among the trees of limited extent are western redcedar and bigleaf maple. The common forest understory plants are creambush oceanspray, western brackenfern, Oregongrape, salal, western swordfern, trailing blackberry, red huckleberry, and rose.

On the basis of a 100-year site curve, the mean site index is 152 for Douglas fir and 164 for western hemlock. On the basis of a 50-year site curve, it is 117 for Douglas fir and 114 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 161 cubic feet per acre per year, occurring at age 60. For western hemlock it is 262 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of red alder have not been made.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVs.

70—Grotto gravelly loamy sand, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on river terraces. It formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, bark, and twigs 2 inches thick. The surface layer is brown gravelly loamy sand 5 inches thick. The upper 14 inches of the subsoil is dark brown very gravelly coarse sand. The lower 17 inches is brown and strong brown very gravelly coarse sand. The substratum to a depth of 60 inches is yellowish brown very gravelly sand. In some areas the surface layer is loamy sand. In other areas the soil has 0 to 35 percent rock fragments in the subsoil or has a subsoil and substratum of sandy loam.

Included in this unit are small areas of Snoqualmie soils and Grotto soils that have slopes of more than 8 percent. Included areas make up about 20 percent of the total acreage.

Permeability is rapid in the Grotto soil. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare flooding.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species.

Among the trees of limited extent are red alder and western redcedar. The common forest understory plants are salal, Oregongrape, red huckleberry, vine maple, western swordfern, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 123. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 119 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVs.

71—Hartnit silt loam, 8 to 30 percent slopes. This well drained soil is on glacially modified mountain ridgetops and back slopes. It is moderately deep to bedrock. It formed in glacial till, volcanic ash, and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 2,800 to 3,600 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 95 days.

Typically, the surface is covered with a mat of decomposed needles, leaves, and twigs 7 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown silt loam. The subsoil is dark brown and dark yellowish brown gravelly silt loam 14 inches thick. The substratum is dark yellowish brown very gravelly silt loam 11 inches thick. Andesite is at a depth of about 31 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock or has less than 6 percent organic carbon in the upper part of the subsoil.

Included in this unit are small areas of Klapatche, Nagrom, Playco, and Stahl soils and Hartnit soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Hartnit soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are western redcedar and Douglas fir. The common forest understory plants are red huckleberry, blueleaved huckleberry, bunchberry dogwood, deer fern, western brackenfern, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 101. On the basis of a 50-year site curve, it is estimated to be 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully

laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

72—Haywire sandy loam, 8 to 30 percent slopes. This well drained soil is on ridgetops and mountain back slopes. It is moderately deep to bedrock. It formed in volcanic ash and pumice over colluvium and residuum derived dominantly from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 6,000 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles and twigs 1 inch thick. When mixed to a depth of 4 inches, the surface layer is dusky red sandy loam. In sequence downward, the subsoil is 5 inches of dark reddish brown loam, 8 inches of dark reddish brown gravelly loam, 8 inches of dark brown very cobbly loam, and 11 inches of dark yellowish brown extremely cobbly loam. Andesite is at a depth of about 36 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, loam, or gravelly loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Nagrom, Nimue, and Playco soils and Haywire soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Haywire soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, deer fern, princes pine, salal, dwarf huckleberry, pachystima, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 87. On the basis of a 50-year site curve, it is 59. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 100 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical

or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

73—Haywire sandy loam, 30 to 65 percent slopes. This well drained soil is on ridgetops and mountain back slopes. It is moderately deep to bedrock. It formed in volcanic ash and pumice over colluvium and residuum derived dominantly from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 6,000 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles and twigs 1 inch thick. When mixed to a depth of 4 inches, the surface layer is dusky red sandy loam. In sequence downward, the subsoil is 5 inches of dark reddish brown loam, 8 inches of dark reddish brown gravelly loam, 8 inches of dark brown very cobbly loam, and 11 inches of dark yellowish brown extremely cobbly loam. Andesite is at a depth of about 36 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, loam, or gravelly loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Nagrom, Nimue, and Playco soils and Haywire soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Haywire soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, deer fern, princes pine, salal, dwarf huckleberry, pachystima, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 87. On the basis of a 50-year site curve, it is 59. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 100 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

74—Haywire loamy sand, tuff substratum, 8 to 30 percent slopes. This well drained soil is on ridgetops and mountain back slopes. It is moderately deep to bedrock. It formed in volcanic ash and pumice over colluvium and residuum derived dominantly from tuff or breccia. The native vegetation is mainly conifers and

shrubs. Elevation is 3,400 to 6,000 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of decomposed needles and twigs 3 inches thick. When mixed to a depth of 8 inches, the surface layer is dusky red loamy sand. The upper 6 inches of the subsoil is dark brown very cobbly loam. The lower 16 inches is dark yellowish brown extremely gravelly loam. Breccia is at a depth of about 30 inches. The depth to tuff or breccia ranges from 20 to 40 inches. In some areas the surface layer is sandy loam, loam, or gravelly sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to tuff, breccia, or andesite.

Included in this unit are small areas of Nagrom, Nimue, and Playco soils and Haywire soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Haywire soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, deer fern, princes pine, salal, dwarf huckleberry, pachystima, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 87. On the basis of a 50-year site curve, it is 59. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 100 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

75—Haywire loamy sand, tuff substratum, 30 to 65 percent slopes. This well drained soil is on ridgetops and mountain back slopes. It is moderately deep to bedrock. It formed in volcanic ash and pumice over colluvium and residuum derived dominantly from tuff or breccia. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 6,000 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of decomposed needles and twigs 3 inches thick. When mixed to a depth of 8 inches, the surface layer is dusky red loamy sand. The upper 6 inches of the subsoil is dark brown very cobbly loam. The lower 16 inches is dark yellowish brown extremely gravelly loam. Breccia

is at a depth of about 30 inches. The depth to tuff or breccia ranges from 20 to 40 inches. In some areas the surface layer is sandy loam, loam, or gravelly sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to tuff, breccia, or andesite.

Included in this unit are small areas of Nagrom, Nimue, and Playco soils and Haywire soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Haywire soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, deer fern, princes pine, salal, dwarf huckleberry, pachystima, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 87. On the basis of a 50-year site curve, it is 59. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 100 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

76—Hinker gravelly sandy loam, 8 to 30 percent slopes. This well drained soil is on glacially modified mountain shoulder slopes. It is moderately deep to bedrock. It formed in volcanic ash and in colluvium derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 4,200 feet. The average annual precipitation is about 95 inches, and the average annual air temperature is about 41 degrees F. The average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 9 inches of the subsoil is dark brown and strong brown very channery loam. The lower 5 inches is dark grayish brown very channery loam. The substratum is dark grayish brown extremely channery loam 16 inches thick. Phyllite is at a depth of about 38 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is very channery sandy loam, gravelly loam, or gravelly loamy sand. In other areas the soil has less than 6 percent organic carbon in the lower part of the subsoil,

is 40 to 60 inches deep to phyllite, or has a less developed subsoil.

Included in this unit are small areas of Crinker, Reggad, and Treen soils, soils that are 20 to 40 inches deep to dense glacial till, soils that are 14 to 20 inches deep to phyllite, Rock outcrop, and Hinker soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the Hinker soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are Alaska cedar and mountain hemlock. The common forest understory plants are tall blue huckleberry, bunchberry dogwood, deer fern, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality phyllite. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

77—Hinker gravelly sandy loam, 30 to 65 percent slopes. This well drained soil is on glacially modified mountain shoulder slopes. It is moderately deep to bedrock. It formed in volcanic ash and in colluvium derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 4,200 feet. The average annual precipitation is about 95 inches, and the average annual air temperature is about 41 degrees F. The average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 9 inches of the subsoil is dark brown and strong brown very channery loam. The lower 5 inches is dark grayish brown very channery loam. The substratum is dark grayish brown extremely channery loam 16 inches thick. Phyllite is at a depth of about 38 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is very channery sandy loam, gravelly loam, or gravelly loamy sand. In other areas the soil has less than 6 percent organic carbon in the lower part of the subsoil, is 40 to 60 inches deep to phyllite, or has a less developed subsoil.

Included in this unit are small areas of soils that are 20 to 40 inches deep to dense glacial till, soils that are 14 to 20 inches deep to phyllite, Rock outcrop, and Hinker soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the Hinker soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are Alaska cedar and

mountain hemlock. The common forest understory plants are tall blue huckleberry, bunchberry dogwood, deer fern, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality phyllite. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

78—Hinker gravelly sandy loam, 65 to 90 percent slopes. This well drained soil is on glacially modified mountain shoulder slopes. It is moderately deep to bedrock. It formed in volcanic ash and in colluvium derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 4,200 feet. The average annual precipitation is about 95 inches, and the average annual air temperature is about 41 degrees F. The average frost-free period is about 85 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 9 inches of the subsoil is dark brown and strong brown very channery loam. The lower 5 inches is dark grayish brown very channery loam. The substratum is dark grayish brown extremely channery loam 16 inches thick. Phyllite is at a depth of about 38 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is very channery sandy loam, gravelly loam, or gravelly loamy sand. In other areas the soil has less than 6 percent organic carbon in the lower part of the subsoil, is 40 to 60 inches deep to phyllite, or has a less developed subsoil.

Included in this unit are small areas of soils that are 20 to 40 inches deep to dense glacial till, soils that are 14 to 20 inches deep to phyllite, Rock outcrop, and Hinker soils that have slopes of more than 90 percent or less than 65 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the Hinker soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are Alaska cedar and mountain hemlock. The common forest understory plants are tall blue huckleberry, bunchberry dogwood, deer fern, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May.

When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality phyllite. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

79—Humaquepts, 0 to 5 percent slopes. These very deep, poorly drained soils are on terraces. They formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 140 days.

No single profile is representative of these soils. One of the more commonly observed ones, however, is covered with a mat of needles, leaves, and twigs 1 inch thick. Typically, the surface layer is very dark grayish brown silt loam 13 inches thick. The subsoil is grayish brown, mottled gravelly silty clay loam 12 inches thick. The substratum to a depth of 60 inches is grayish brown very gravelly loam. The distribution of organic carbon varies with increasing depth. The surface layer is organic or mineral. In some areas the subsoil and substratum are very cobbly loam.

Included in this unit are small areas of organic soils and alluvial soils. The alluvial soils are better drained than the Humaquepts. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately slow in the Humaquepts. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at a depth of 0.5 to 1.0 foot from December through April. The soils are subject to rare periods of flooding. Runoff is very slow, and there is no hazard of erosion.

This unit is used for woodland or wildlife habitat. Red alder is the main woodland species. Among the trees of limited extent are western redcedar, Sitka spruce, black cottonwood, and western hemlock. The common forest understory plants are willows, sedges, rushes, salmonberry, and thimbleberry.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 85. The highest average growth rate in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soils are moist and a high degree of puddling when the soils are wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. When the surface layer is removed by harvesting activities, seedlings planted in the less fertile underlying material grow poorly and lack vigor. Reforestation can be accomplished by planting western redcedar, Sitka spruce, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder and western redcedar occurs

occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soils are wet and winds are strong.

This unit is in capability subclass VIw.

80—Index loamy sand, 8 to 30 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice mixed with colluvium derived dominantly from granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown loamy sand. The upper 8 inches of the subsoil is dark brown very cobbly loamy sand. The lower 8 inches is dark yellowish brown very gravelly loamy sand. The upper 17 inches of the substratum is light yellowish brown extremely cobbly sand. The lower 17 inches is pale yellow extremely cobbly sand. Highly weathered granodiorite is at a depth of about 57 inches. The depth to granitic or metamorphic rocks ranges from 40 to 70 inches. In some areas the surface layer is sandy loam, gravelly loamy sand, or very gravelly loamy sand. In other areas the soil has a substratum of very gravelly sandy loam, has 15 to 35 percent rock fragments in the subsoil, or is underlain by conglomerate.

Included in this unit are small areas of Klapatche soils, soils that are 10 to 20 deep inches to bedrock, Rock outcrop, and Index soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid in the Index soil. Available water capacity is low. The effective rooting depth is 40 to 70 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Douglas fir, and Alaska cedar. The common forest understory plants are salal, huckleberry, common beargrass, longtube twinflower, bunchberry dogwood, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 111. On the basis of a 50-year site curve, it is estimated to be 81. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 162 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIs.

81—Index loamy sand, 30 to 65 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice mixed with colluvium derived dominantly from granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of

needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown loamy sand. The upper 8 inches of the subsoil is dark brown very cobbly loamy sand. The lower 8 inches is dark yellowish brown very gravelly loamy sand. The upper 17 inches of the substratum is light yellowish brown extremely cobbly sand. The lower 17 inches is pale yellow extremely cobbly sand. Highly weathered granodiorite is at a depth of about 57 inches. The depth to granitic or metamorphic rocks ranges from 40 to 70 inches. In some areas the surface layer is sandy loam, gravelly loamy sand, or very gravelly loamy sand. In other areas the soil has a substratum of very gravelly sandy loam, has 15 to 35 percent rock fragments in the subsoil, or is underlain by conglomerate.

Included in this unit are small areas of Klapatche soils, soils that are 10 to 20 inches deep to bedrock, Rock outcrop, and Index soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid in the Index soil. Available water capacity is low. The effective rooting depth is 40 to 70 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Douglas fir, and Alaska cedar. The common forest understory plants are salal, huckleberry, common beargrass, longtube twinflower, bunchberry dogwood, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 111. On the basis of a 50-year site curve, it is estimated to be 81. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 162 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIIs.

82—Index loamy sand, 65 to 90 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice mixed with colluvium derived dominantly from granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown loamy sand. The upper 8 inches of the subsoil is dark brown very cobbly loamy sand. The lower 8 inches is dark yellowish brown very gravelly loamy sand. The upper 17 inches of the substratum is light yellowish brown extremely cobbly sand. The lower 17 inches is pale yellow extremely cobbly sand. Highly weathered granodiorite is at a depth of about 57 inches. The depth to granitic or metamorphic rocks ranges from 40 to 70 inches. In some areas the surface layer is sandy loam, gravelly loamy sand, or very gravelly loamy sand. In other areas the soil has a substratum of very gravelly sandy loam, has 15 to 35 percent rock fragments in the subsoil, or is underlain by conglomerate.

Included in this unit are small areas of Klapatche soils, soils that are 10 to 20 inches deep to bedrock, Rock outcrop, and Index soils that have slopes of less than 65 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid in the Index soil. Available water capacity is low. The effective rooting depth is 40 to 70 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Douglas fir, and Alaska cedar. The common forest understory plants are salal, huckleberry, common beargrass, longtube twinflower, bunchberry dogwood, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 111. On the basis of a 50-year site curve, it is estimated to be 81. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 162 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock or Pacific silver fir occurs periodically.

This unit is in capability subclass VIIs.

83—Index-Rock outcrop complex, 45 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

This unit is 45 percent Index loamy sand and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Klapatche and Reggad soils, talus, soils that are 10 to 20 inches deep over bedrock, and Index soils that have slopes of less than 45 percent. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

The Index soil is deep and well drained. It formed in volcanic ash and pumice mixed with colluvium derived dominantly from granitic and metamorphic rocks. Typically, the surface is covered with a mat of needles, twigs, bark, and moss 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown loamy sand. The upper 8 inches of the subsoil is dark brown very cobbly loamy sand. The lower 8 inches is dark yellowish brown very gravelly loamy sand. The upper 17 inches of the substratum is light yellowish brown extremely cobbly sand. The lower 17 inches is pale yellow extremely cobbly sand. Highly weathered granodiorite is at a depth of about 57 inches. The depth to granitic or metamorphic rocks ranges from 40 to 70 inches. In some areas the surface layer is sandy loam, gravelly loamy sand, or very gravelly loamy sand. In other areas the soil has a substratum of very gravelly sandy loam, has 15 to 35 percent rock fragments in the subsoil, or is underlain by conglomerate.

Permeability is rapid in the Index soil. Available water capacity is low. The effective rooting depth is 40 to 70 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is granitic or

metamorphic rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Douglas fir, and Alaska cedar. The common forest understory plants are salal, huckleberry, common beargrass, longtube twinflower, bunchberry dogwood, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 111. On the basis of a 50-year site curve, it is estimated to be 81. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 162 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 30 percent of this unit.

The main limitations affecting timber harvesting are snowpack, the Rock outcrop, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation.

The Index soil is in capability subclass VIIs. The Rock outcrop is in capability subclass VIIIs.

84—Jonas gravelly loam, tuff substratum, 15 to 30 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in colluvium and residuum derived from tuff and breccia. The colluvium and residuum have an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly loam 6 inches thick. The subsoil also is dark brown gravelly loam. It is 37 inches thick. The substratum is dark brown very gravelly loam 11 inches thick. Weathered tuff is at a depth of about 54 inches. The depth to weathered tuff or breccia ranges from 40 to 60 inches. In some areas the surface layer is gravelly silt loam or very gravelly loam. In other areas the soil has 35 to 50 percent rock fragments in the subsoil, is underlain by andesite, or is more than 60 inches deep over bedrock.

Included in this unit are small areas of Littlejohn, Pheeney, Pitcher, and Zynbar soils and Jonas soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Jonas soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are red huckleberry, violet, wild ginger, salal, western swordfern, western brackenfern, blackberry, vine maple, Oregon oxalis, Oregongrape, blueleaved huckleberry, Pacific trillium, and bedstraw.

On the basis of a 100-year site curve, the mean site index is 158 for Douglas fir and 160 for western hemlock. On the basis of a 50-year site curve, it is 121 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 168 cubic feet per acre per year, occurring at age 65. For western hemlock it is 254 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

85—Jonas gravelly loam, tuff substratum, 30 to 65 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in colluvium and residuum derived from tuff and breccia. The colluvium and residuum have an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly loam 6 inches thick. The subsoil also is dark brown gravelly loam. It is 37 inches thick. The substratum is dark brown very gravelly loam 11 inches thick. Weathered tuff is at a depth of about 54 inches. The depth to weathered tuff or breccia ranges from 40 to 60 inches. In some areas the surface layer is gravelly silt loam or very gravelly loam. In other areas the soil has 35 to 50 percent rock fragments in the subsoil, is underlain by andesite, or is more than 60 inches deep over bedrock.

Included in this unit are small areas of Littlejohn, Pheeney, Pitcher, and Zynbar soils and Jonas soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Jonas soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are red huckleberry, violet, wild ginger, salal, western swordfern, western brackenfern, blackberry, vine maple, Oregon oxalis, Oregongrape, blueleaved huckleberry, Pacific trillium, and bedstraw.

On the basis of a 100-year site curve, the mean site index is 158 for Douglas fir and 160 for western hemlock. On the basis of a 50-year site curve, it is 121 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 168 cubic feet per acre per year, occurring at age 65. For western hemlock it is 254 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully

laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

86—Jonas gravelly silt loam, 15 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in colluvium and residuum derived from andesite. The colluvium and residuum have an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly silt loam 16 inches thick. The subsoil is dark brown gravelly clay loam 26 inches thick. The substratum to a depth of 60 inches is dark yellowish brown gravelly clay loam. In some areas the surface layer is gravelly or very gravelly loam. In other areas the soil has 35 to 50 percent rock fragments in the subsoil or is underlain by andesite or breccia at a depth of 40 to 60 inches.

Included in this unit are small areas of Littlejohn, Pheeney, Pitcher, and Zynbar soils and Jonas soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Jonas soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are red huckleberry, violet, wild ginger, salal, western swordfern, western brackenfern, blackberry, vine maple, Oregon oxalis, Oregongrape, blueleaved huckleberry, Pacific trillium, and bedstraw.

On the basis of a 100-year site curve, the mean site index is 158 for Douglas fir and 110 for western hemlock. On the basis of a 50-year site curve, it is 121 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 168 cubic feet per acre per year, occurring at age 65. For western hemlock it is 254 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

87—Jonas gravelly silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in colluvium and residuum derived from andesite. The colluvium and residuum have an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is

about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly silt loam 16 inches thick. The subsoil is dark brown gravelly clay loam 26 inches thick. The substratum to a depth of 60 inches is dark yellowish brown gravelly clay loam. In some areas the surface layer is gravelly or very gravelly loam. In other areas the soil has 35 to 50 percent rock fragments in the subsoil or is underlain by andesite or breccia at a depth of 40 to 60 inches.

Included in this unit are small areas of Littlejohn, Pheeney, Pitcher, and Zynbar soils and Jonas soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Jonas soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are red huckleberry, violet, wild ginger, salal, western swordfern, western brackenfern, blackberry, vine maple, Oregon oxalis, Oregongrape, blueleaved huckleberry, Pacific trillium, and bedstraw.

On the basis of a 100-year site curve, the mean site index is 158 for Douglas fir and 160 for western hemlock. On the basis of a 50-year site curve, it is 121 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 168 cubic feet per acre per year, occurring at age 65. For western hemlock it is 254 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

88—Jonas gravelly silt loam, 65 to 90 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in colluvium and residuum derived from andesite. The colluvium and residuum have an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly silt loam 16 inches thick. The subsoil is dark brown gravelly clay loam 26 inches thick. The substratum to a depth of 60 inches is dark yellowish brown gravelly clay loam. In some areas the surface layer is gravelly or very gravelly loam. In other areas the soil has 35 to 50 percent rock fragments in the subsoil or is underlain by andesite or breccia at a depth of 40 to 60 inches.

Included in this unit are small areas of Littlejohn, Pheeney, Pitcher, and Zynbar soils, Rock outcrop, and Jonas soils that have slopes of less than 65 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Jonas soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf

maple, and western redcedar. The common forest understory plants are red huckleberry, violet, wild ginger, salal, western swordfern, western brackenfern, blackberry, vine maple, Oregon oxalis, Oregongrape, blueleaved huckleberry, Pacific trillium, and bedstraw.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 158 and for western hemlock is 160. On the basis of a 50-year site curve, the mean site index for Douglas fir is 121 and for western hemlock is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 168 cubic feet per acre per year, occurring at age 65. For western hemlock it is 254 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Extra rock is needed to maintain a stable and uniform road surface. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

89—Kaleetan sandy loam, 8 to 30 percent slopes. This very deep, well drained soil is on glacially modified mountain back slopes and toe slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from andesite and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. When mixed to a depth of 4 inches, the surface layer is dark reddish brown sandy loam. The upper 5 inches of the subsoil is variegated dark brown and yellowish red gravelly sandy loam. The lower 26 inches is brown and yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown extremely gravelly sandy loam. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil has a substratum of loamy sand, is 40 to 60 inches deep to dense glacial till or bedrock, is moderately well drained, or has less than 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Philippa, Marblemount, Littlejohn, and Pitcher soils, slump areas, poorly drained soils in depressions, and Kaleetan soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kaleetan soil. Available water capacity also is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are Oregongrape, salal, western swordfern, red huckleberry, Pacific trillium, vine maple, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 145. On the basis of a 50-year site curve, it is 113. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 152 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet

causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Plant competition is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIe.

90—Kaleetan sandy loam, 30 to 65 percent slopes. This very deep, well drained soil is on glacially modified mountain back slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from andesite and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. When mixed to a depth of 4 inches, the surface layer is dark reddish brown sandy loam. The upper 5 inches of the subsoil is variegated dark brown gravelly sandy loam. The lower 26 inches is brown and yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown very gravelly sandy loam and extremely gravelly sandy loam. In some areas the soil has a substratum of loamy sand, is 40 to 60 inches deep to dense glacial till or bedrock, is moderately well drained, or has less than 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Littlejohn, Marblemount, Philippa, and Pitcher soils, slump areas, and Kaleetan soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kaleetan soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are Oregongrape, salal, western swordfern, red huckleberry, Pacific trillium, vine maple, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 145. On the basis of a 50-year site curve, it is 113. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 152 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs

periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

91—Kaleetan sandy loam, windswept, 30 to 65 percent slopes. This very deep, well drained soil is on glacially modified mountain back slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from andesite and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. When mixed to a depth of 4 inches, the surface layer is dark reddish brown sandy loam. The upper 5 inches of the subsoil is variegated dark brown gravelly sandy loam. The lower 26 inches is brown and yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown very gravelly sandy loam and extremely gravelly sandy loam. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil has a substratum of loamy sand, is 40 to 60 inches deep to dense glacial till or bedrock, is moderately well drained, or has less than 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Littlejohn, Marblemount, Philippa, and Pitcher soils, slump areas, and Kaleetan soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kaleetan soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are Oregongrape, salal, western swordfern, red huckleberry, Pacific trillium, vine maple, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 117. On the basis of a 50-year site curve, it is 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

92—Kaleetan sandy loam, till substratum, 8 to 30 percent slopes. This deep, well drained soil is on glacially modified mountain back slopes and toe slopes. It formed in a mixture of volcanic ash and colluvium over andesite and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. When mixed

to a depth of 5 inches, the surface layer is dark reddish brown sandy loam. The upper 7 inches of the subsoil is dark yellowish brown gravelly sandy loam. The lower 11 inches is dark yellowish brown very gravelly loam. The substratum is olive brown very gravelly loamy sand 18 inches thick. Dense glacial till is at a depth of about 41 inches. The depth to dense glacial till ranges from 40 to 60 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil is more than 60 inches deep to dense glacial till or has less than 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Littlejohn, Marblemount, Philippa, and Pitcher soils, soils that are similar to this Kaleetan soil but have dense glacial till at a depth of 20 to 40 inches, slump areas, poorly drained soils in depressions, and Kaleetan soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kaleetan soil. Available water capacity also is moderate. The effective rooting depth is 40 to 60 inches. Water is perched above the dense glacial till from November through March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are Oregongrape, salal, western swordfern, red huckleberry, Pacific trillium, vine maple, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index is 140 for Douglas fir and 125 for western hemlock. On the basis of a 50-year site curve, it is 109 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 145 cubic feet per acre per year, occurring at age 65. For western hemlock it is 190 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIe.

93—Kaleetan sandy loam, till substratum, 30 to 65 percent slopes. This deep, well drained soil is on glacially modified mountain back slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from andesite and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown sandy loam. The upper 7 inches of the subsoil is dark yellowish brown gravelly sandy loam. The lower 11 inches is dark yellowish brown very gravelly loam. The substratum is olive brown very gravelly loamy sand 18 inches thick. Dense glacial till is at a depth of about 41 inches. The depth to dense glacial till ranges from 40 to 60 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil is more than 60 inches deep to dense glacial till or has less than 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Littlejohn, Marblemount, Philippa, and Pitcher soils, soils that are similar to this Kaleetan soil but have dense glacial till at a depth of 20 to 40 inches, slump areas, and Kaleetan soils that have slopes of more than 65 percent or less

than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kaleetan soil. Available water capacity also is moderate. The effective rooting depth is 40 to 60 inches. Water is perched above the dense glacial till from November through March. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are Oregongrape, salal, western swordfern, red huckleberry, Pacific trillium, vine maple, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index is 140 for Douglas fir and 125 for western hemlock. On the basis of a 50-year site curve, it is 109 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 145 cubic feet per acre per year, occurring at age 65. For western hemlock it is 190 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

94—Kaleetan sandy loam, tuff substratum, 8 to 30 percent slopes. This very deep, well drained soil is on glacially modified mountain back slopes and toe slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from tuff, breccia, and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown sandy loam. The upper 11 inches of the subsoil is dark yellowish brown gravelly sandy loam. The lower 17 inches is dark brown very gravelly loam. The substratum to a depth of 60 inches is brown extremely gravelly sandy loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil has a substratum of very gravelly loamy sand, is 40 to 60 inches deep to dense glacial till or bedrock, is moderately well drained, or has less than 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Littlejohn, Marblemount, Philippa, and Pitcher soils, slump areas, poorly drained soils in depressions, and Kaleetan soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kaleetan soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are Oregongrape, salal, western swordfern, red huckleberry, Pacific trillium, vine maple, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 145. On the basis of a 50-year site curve, it is 113. The highest average growth rate in

unmanaged, even-aged stands of Douglas fir is 152 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIe.

95—Kaleetan sandy loam, tuff substratum, 30 to 65 percent slopes. This very deep, well drained soil is on glacially modified mountain back slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from tuff, breccia, and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown sandy loam. The upper 11 inches of the subsoil is dark yellowish brown gravelly sandy loam. The lower 17 inches is dark brown very gravelly loam. The substratum to a depth of 60 inches is brown extremely gravelly sandy loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil has a substratum of loamy sand, is 40 to 60 inches deep to dense glacial till or bedrock, is moderately well drained, or has less than 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Littlejohn, Marblemount, Philippa, and Pitcher soils, slump areas, and Kaleetan soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kaleetan soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are Oregongrape, salal, western swordfern, red huckleberry, Pacific trillium, vine maple, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 145. On the basis of a 50-year site curve, it is 113. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 152 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January though March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil

is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

96—Kanaskat gravelly sandy loam, 0 to 30 percent slopes. This very deep, well drained soil is on back slopes in the foothills. It formed in a mixture of volcanic ash, colluvium, and material weathered from extrusive rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,700 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 155 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is grayish brown gravelly sandy loam 11 inches thick. The upper 12 inches of the subsoil is dark yellowish brown extremely gravelly loam. The lower 15 inches is yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches is light olive brown extremely gravelly coarse sandy loam. In some areas the surface layer is very gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Ogarty soils and Kanaskat soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kanaskat soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, bigleaf maple, and western redcedar. The common forest understory plants are salal, Oregongrape, western swordfern, longtube twinflower, western brackenfern, vine maple, red huckleberry, trailing blackberry, and bitter cherry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 144. On the basis of a 50-year site curve, it is 113. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

97—Kanaskat gravelly sandy loam, 30 to 65 percent slopes. This very deep, well drained soil is on back slopes in the foothills. It formed in a mixture of volcanic ash, colluvium, and material weathered from extrusive rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,700 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 155 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is grayish brown gravelly sandy loam 11 inches thick. The upper 12 inches of the subsoil is dark yellowish brown extremely gravelly loam. The lower 15 inches is yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches is light olive brown extremely gravelly coarse sandy loam. In some areas the surface layer is very gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Ogarty soils and Kanaskat soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kanaskat soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, bigleaf maple, and western redcedar. The common forest understory plants are salal, Oregongrape, western swordfern, longtube twinflower, western brackenfern, vine maple, red huckleberry, trailing blackberry, and bitter cherry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 144. On the basis of a 50-year site curve, it is 113. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

98—Kanaskat gravelly sandy loam, tuff substratum, 8 to 30 percent slopes. This very deep, well drained soil is on back slopes in the foothills. It formed in a mixture of volcanic ash, colluvium, and material weathered from tuff and breccia. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,700 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 155 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown gravelly sandy loam 7 inches thick. The upper 11 inches of the subsoil is dark reddish brown and yellowish brown very gravelly sandy loam. The lower 12 inches is dark brown very gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown very gravelly sandy loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is very gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Ogarty soils and Kanaskat soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kanaskat soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, bigleaf maple, and western redcedar. The common forest understory plants are salal, Oregongrape, western swordfern, longtube twinflower, western brackenfern, vine maple, red huckleberry, trailing blackberry, and bitter cherry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 144. On the basis of a 50-year site curve, it is 113. The highest average growth rate in

unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

99—Kanaskat gravelly sandy loam, tuff substratum, 30 to 65 percent slopes. This very deep, well drained soil is on back slopes in the foothills. It formed in a mixture of volcanic ash, colluvium, and material weathered from tuff and breccia. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,700 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 155 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown gravelly sandy loam 7 inches thick. The upper 11 inches of the subsoil is dark reddish brown and yellowish brown very gravelly sandy loam. The lower 12 inches is dark brown very gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown very gravelly sandy loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is very gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Ogarty soils and Kanaskat soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kanaskat soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, bigleaf maple, and western redcedar. The common forest understory plants are salal, Oregongrape, western swordfern, longtube twinflower, western brackenfern, vine maple, red huckleberry, trailing blackberry, and bitter cherry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 144. On the basis of a 50-year site curve, it is 113. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

100—Kapowsin gravelly loam, 6 to 15 percent slopes. This moderately well drained soil is on glacial till plains. It is moderately deep to ortstein. It formed in dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 800 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is very dark grayish brown gravelly loam 9 inches thick. The upper 15 inches of the subsoil is dark brown gravelly loam. The lower 13 inches is dark yellowish brown gravelly sandy loam. Brown ortstein that crushes to gravelly sandy loam is at a depth of about 37 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam or very gravelly loam. In other areas the soil is 40 to 60 inches deep to ortstein.

Included in this unit are small areas of Alderwood, Barneston, Lynnwood, and Norma soils and Kapowsin soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Kapowsin soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from December through June. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used as pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used as woodland. If irrigated, it also is suitable as pasture and hayland.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. The common forest understory plants are Oregongrape, western brackenfern, western swordfern, vine maple, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 161. On the basis of a 50-year site curve, it is 123. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of planted Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IIIe.

101—Kapowsin gravelly loam, 15 to 30 percent slopes. This moderately well drained soil is on glacial till plains. It is moderately deep to ortstein. It formed in dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 800 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is very dark grayish brown gravelly loam 9 inches thick. The upper 15 inches of the subsoil is dark brown gravelly loam. The lower 13 inches is dark yellowish brown gravelly sandy loam. Brown ortstein that crushes to gravelly sandy loam is at a depth of about 37 inches. The depth to ortstein ranges from 20 to 40 inches. In

some areas the surface layer is gravelly silt loam or very gravelly loam. In other areas the soil is 40 to 60 inches deep to ortstein.

Included in this unit are small areas of Alderwood, Barneston, and Lynnwood soils and Kapowsin soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Kapowsin soil and very slow in the ortstein. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from December through June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. The common forest understory plants are Oregongrape, western brackenfern, western swordfern, vine maple, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 161. On the basis of a 50-year site curve, it is 123. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of planted Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

102—Kapowsin gravelly loam, 30 to 65 percent slopes. This moderately well drained soil is on glacial till plains. It is moderately deep to ortstein. It formed in dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 800 feet. The average annual precipitation is about 40 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is very dark grayish brown gravelly loam 9 inches thick. The upper 15 inches of the subsoil is dark brown gravelly loam. The lower 13 inches is dark yellowish brown gravelly sandy loam. Brown ortstein that crushes to gravelly sandy loam is at a depth of about 37 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam or very gravelly loam. In other areas the soil is 40 to 60 inches deep to ortstein.

Included in this unit are small areas of Alderwood, Barneston, and Lynnwood soils and Kapowsin soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Kapowsin soil and very slow in the ortstein. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from December through June. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, western hemlock, and bigleaf maple. The common forest understory plants are Oregongrape, western brackenfern, western swordfern, vine maple, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 161. On the basis of a 50-year site curve, it is 123. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to

deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of planted Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

103—Kindy gravelly loam, 0 to 15 percent slopes. This moderately well drained soil is on glacially modified mountain back slopes and plateaus. It is moderately deep to ortstein. It formed in a mixture of volcanic ash and colluvium over dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,700 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly loam. The upper 4 inches of the subsoil is dark reddish brown and yellowish red gravelly silt loam. The next 13 inches is dark brown and dark yellowish brown very gravelly loam. The lower 9 inches is brown and strong brown very gravelly sandy loam. Dark grayish brown ortstein that crushes to very gravelly sandy loam is at a depth of about 32 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is gravelly sandy loam, gravelly silt loam, or very gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock or dense glacial till.

Included in this unit are small areas of Index, Klapatche, and Playco soils, Rock outcrop, and Kindy soils that have slopes of more than 15 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Kindy soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common forest understory plants are tall blue huckleberry, salmonberry, deer fern, western brackenfern, red huckleberry, and salal.

On the basis of a 100-year site curve, the mean site index is 135 for western hemlock and is estimated to be 120 for Douglas fir. On the basis of a 50-year site curve, it is 96 for western hemlock and is estimated to be 95 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 209 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 115 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from December through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The

seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

104—Kindy gravelly loam, 15 to 30 percent slopes. This moderately well drained soil is on glacially modified mountain back slopes and plateaus. It is moderately deep to ortstein. It formed in a mixture of volcanic ash and colluvium over dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,700 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly loam. The upper 4 inches of the subsoil is dark reddish brown and yellowish red gravelly silt loam. The next 13 inches is dark brown and dark yellowish brown very gravelly loam. The lower 9 inches is brown and strong brown very gravelly sandy loam. Dark grayish brown ortstein that crushes to very gravelly sandy loam is at a depth of about 32 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is gravelly sandy loam, gravelly silt loam, or very gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock or dense glacial till.

Included in this unit are small areas of Index, Klapatche, and Playco soils, Rock outcrop, and Kindy soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Kindy soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common forest understory plants are tall blue huckleberry, salmonberry, deer fern, western brackenfern, red huckleberry, and salal.

On the basis of a 100-year site curve, the mean site index is 135 for western hemlock and is estimated to be 120 for Douglas fir. On the basis of a 50-year site curve, it is 96 for western hemlock and is estimated to be 95 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 209 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 115 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from December through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally

subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

105—Kindy gravelly loam, 30 to 65 percent slopes. This moderately well drained soil is on glacially modified mountain back slopes and plateaus. It is moderately deep to ortstein. It formed in a mixture of volcanic ash and colluvium over dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,700 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly loam. The upper 4 inches of the subsoil is dark reddish brown and yellowish red gravelly silt loam. The next 13 inches is dark brown and dark yellowish brown very gravelly loam. The lower 9 inches is brown and strong brown very gravelly sandy loam. Dark grayish brown ortstein that crushes to very gravelly sandy loam is at a depth of about 32 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is gravelly sandy loam, gravelly silt loam, or very gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock or dense glacial till.

Included in this unit are small areas of Index, Klapatche, and Playco soils, Rock outcrop, and Kindy soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Kindy soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common forest understory plants are tall blue huckleberry, salmonberry, deer fern, western brackenfern, red huckleberry, and salal.

On the basis of a 100-year site curve, the mean site index is 135 for western hemlock and is estimated to be 120 for Douglas fir. On the basis of a 50-year site curve, it is 96 for western hemlock and is estimated to be 95 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 209 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 115 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from December through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

106—Klaber silt loam, 0 to 8 percent slopes. This very deep, poorly drained soil is on terraces. It formed in lacustrine sediments. The native vegetation is mainly trees and shrubs. Elevation is 100 to 600 feet. The average annual precipitation is about 55 inches, and the

average annual air temperature is about 50 degrees F. The average frost-free period is about 175 days.

When mixed to a depth of 6 inches, the surface layer is very dark grayish brown silt loam. The upper 5 inches of the subsurface layer also is very dark grayish brown silt loam. The lower 11 inches is light brownish gray, mottled silt loam. The upper 14 inches of the subsoil is grayish brown, mottled silty clay. The lower part to a depth of 60 inches is gray silty clay. In some areas the surface layer is silty clay loam or silty clay. In other areas the soil has 20 to 35 percent clay or more than 42 percent clay in the subsoil or substratum.

Included in this unit are small areas of Pastik soils and ponded areas. Included areas make up about 10 percent of the total acreage.

Permeability is slow in the Klaber soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from November through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. It also is suitable as pasture and hayland.

Red alder is the main woodland species. Among the trees of limited extent are Douglas fir, western redcedar, bigleaf maple, and Oregon ash. The common forest understory plants are salal, western brackenfern, western swordfern, spirea, rose, vine maple, and sedges.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIw.

107—Klaber-Cinebar silt loams, 0 to 8 percent slopes. This map unit is on terraces and toe slopes in the foothills. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,000 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 175 days.

This unit is 60 percent Klaber silt loam, 0 to 3 percent slopes, and 30 percent Cinebar silt loam, 0 to 8 percent slopes. The Klaber soil is in slight depressions. The Cinebar soil is on elongated knolls. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Mashel, Pastik, Scamman, and Wilkeson soils and Cinebar soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

The Klaber soil is very deep and poorly drained. It formed in lacustrine sediments. When mixed to a depth of 6 inches, the surface layer is very dark grayish brown silt loam. The upper 5 inches of the subsurface layer also is very dark grayish brown silt loam. The lower 11 inches is light brownish gray, mottled silt loam. The upper 14 inches of the subsoil is grayish brown, mottled silty clay. The lower part to a depth of 60 inches is gray silty clay. In some areas the surface layer is silty clay loam. In other areas the soil has 20 to 35 percent clay or more than 60 percent clay in the subsoil or substratum.

Permeability is slow in the Klaber soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from November through May. Runoff is slow, and the hazard of water erosion is slight.

The Cinebar soil is very deep and well drained. It formed in loess, volcanic ash, and slope alluvium. Typically, the surface is covered with a mat of needles, leaves, twigs, and moss 2 inches thick. The surface layer is dark brown silt loam 10 inches thick. The

subsoil is dark brown and yellowish brown silt loam 44 inches thick. The substratum to a depth of 60 inches is yellowish brown loam. In some areas the surface layer is loam. In other areas the soil has strata of sandy material in the subsoil.

Permeability is moderate in the Cinebar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. It also is suitable as pasture and hayland.

Douglas fir, red alder, and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and bigleaf maple. The common forest understory plants are salal, western brackenfern, western swordfern, Oregongrape, red huckleberry, spirea, rose, vine maple, trillium, devilsclub, oxalis, and sedges.

On the basis of a 50-year site curve, the mean site index for red alder on the Klaber soil is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of red alder on this soil is about 101 cubic feet per acre per year, occurring at age 40.

On the basis of a 100-year site curve, the mean site index on the Cinebar soil is 174 for Douglas fir and 155 for western hemlock. On the basis of a 50-year site curve, it is 132 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir on this soil is 185 cubic feet per acre per year, occurring at age 60. For western hemlock it is 246 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soils are moist and a high degree of puddling when the soils are wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortaiity, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table in the Klaber soil hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar on the Klaber soil and Douglas fir on the Cinebar soil. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table in the Klaber soil, trees are frequently subject to windthrow when the soil is wet and winds are strong.

The Klaber soil is in capability subclass VIw. The Cinebar soil is in capability subclass IIe.

108—Klapatche loamy sand, 8 to 30 percent slopes. This well drained soil is on glacially modified mountain ridge crests and back slopes. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and pumice over colluvium derived dominantly from granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 4,000 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown loamy sand. The upper 4 inches of the subsoil is yellowish red and dark reddish brown very gravelly sandy loam. The lower 8 inches is strong brown very gravelly loamy sand. The upper 11 inches of the substratum is very pale brown extremely cobbly sand. The lower 7 inches is light gray, highly weathered granodiorite. Hard granodiorite is at a depth of about 38 inches. The depth to hard granitic or metamorphic rocks ranges from 30 to 40 inches. In some areas the surface layer is sandy loam, gravelly loamy sand, or very gravelly loamy sand. In other areas the soil has a substratum of very gravelly sandy loam, has 15 to 35 percent rock fragments in the subsoil, or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Nagrom and Playco soils, soils that are 10 to 20 inches deep over bedrock, Rock outcrop, and Klapatche soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Klapatche

soil. Available water capacity is low. The effective rooting depth is 30 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Douglas fir, and Alaska cedar. The common forest understory plants are huckleberry, common beargrass, salal, longtube twinflower, bunchberry dogwood, Oregongrape, princes pine, and Sitka alder.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 101. On the basis of a 50-year site curve, it is estimated to be 72. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIs.

109—Klapatche loamy sand, 30 to 65 percent slopes. This well drained soil is on glacially modified mountain back slopes. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and pumice over colluvium derived dominantly from granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 4,000 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown loamy sand. The upper 4 inches of the subsoil is yellowish red and dark reddish brown very gravelly sandy loam. The lower 8 inches is strong brown very gravelly loamy sand. The upper 11 inches of the substratum is very pale brown extremely cobbly sand. The lower 7 inches is light gray, highly weathered granodiorite. Hard granodiorite is at a depth of about 38 inches. The depth to hard granitic or metamorphic rocks ranges from 30 to 40 inches. In some areas the surface layer is sandy loam, gravelly loamy sand, or very gravelly loamy sand. In other areas the soil has a substratum of very gravelly sandy loam, has 15 to 35 percent rock fragments in the subsoil, or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Nagrom and Playco soils, soils that are 10 to 20 inches deep over bedrock, Rock outcrop, and Klapatche soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Klapatche soil. Available water capacity is low. The effective rooting depth is 30 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Douglas fir, and Alaska cedar. The common forest understory plants are

huckleberry, common beargrass, salal, longtube twinflower, bunchberry dogwood, Oregongrape, princes pine, and Sitka alder.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 101. On the basis of a 50-year site curve, it is estimated to be 72. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIs.

110—Klapatche-Rock outcrop complex, 45 to 90 percent slopes. This map unit is on glacially modified mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 4,000 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

This unit is 45 percent Klapatche loamy sand and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Nagrom, Playco, and Reggad soils, talus, soils that are 10 to 20 inches deep over bedrock, and Klapatche soils that have slopes of less than 45 percent. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

The Klapatche soil is moderately deep to bedrock and is well drained. It formed in a mixture of volcanic ash and pumice over colluvium derived dominantly from granitic and metamorphic rocks. Typically, the surface is covered with a mat of needles, twigs, bark, and moss 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown loamy sand. The upper 4 inches of the subsoil is yellowish red and dark reddish brown very gravelly sandy loam. The lower 8 inches is strong brown very gravelly loamy sand. The upper 11 inches of the substratum is very pale brown extremely cobbly sand. The lower 7 inches is light gray, highly weathered granodiorite. Hard granodiorite is at a depth of about 38 inches. The depth to hard granitic or metamorphic rocks ranges from 30 to 40 inches. In some areas the surface layer is sandy loam, gravelly loamy sand, or very gravelly loamy sand. In other areas the soil has a substratum of very gravelly sandy loam, has 15 to 35 percent rock fragments in the subsoil, or is 40 to 60 inches deep over bedrock.

Permeability is moderately rapid in the Klapatche soil. Available water capacity is low. The effective rooting depth is 30 to 40 inches. Runoff is medium or rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is granitic or metamorphic rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, Douglas fir, and Alaska cedar. The common forest understory plants are huckleberry, common beargrass, salal, longtube twinflower, bunchberry dogwood, Oregongrape, princes pine, and Sitka alder.

On the basis of a 100-year site curve, the mean site

index for western hemlock is estimated to be 101. On the basis of a 50-year site curve, it is estimated to be 72. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 30 percent of this unit.

The main limitations affecting timber harvesting are snowpack, the Rock outcrop, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Klapatche soil is in capability subclass VIIs. The Rock outcrop is in capability subclass VIIIs.

111—Klaus sandy loam, 0 to 8 percent slopes. This moderately deep, well drained soil is on terraces. It formed in a mixture of volcanic ash and alluvium over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 700 to 1,400 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 155 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2.5 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown sandy loam. The upper 9 inches of the subsoil is dark brown gravelly sandy loam. The lower 12 inches is brown very gravelly sand. Iron-cemented, brown extremely gravelly sand is at a depth of about 28 inches. The depth to iron-cemented material ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, the depth to iron-cemented material is 40 to 60 inches, or the subsoil is very gravelly sandy loam.

Included in this unit are small areas of Cinebar, Nargar, Norma, Ogarty, Persis, and Ragnar soils, poorly drained soils in depressions, and Klaus soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Klaus soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used as a source of aggregate.

Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent is western redcedar. The common forest understory plants are salal, western swordfern, red huckleberry, vine maple, Oregongrape, deer fern, longtube twinflower, trailing blackberry, and creambush oceanspray.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 142. On the basis of a 50-year site curve, it is 111. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 148 cubic feet per acre per year, occurring at age 65.

Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the iron-cemented material in the lower part of the substratum, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

112—Klaus sandy loam, 8 to 15 percent slopes. This moderately deep, well drained soil is on terraces. It formed in a mixture of volcanic ash and alluvium over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 700 to 1,400 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 155 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2.5 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown sandy loam. The upper 9 inches of the subsoil is dark brown gravelly sandy loam. The lower 12 inches is brown very gravelly sand. Iron-cemented, brown extremely gravelly sand is at a depth of about 28 inches. The depth to iron-cemented material ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, the depth to iron-cemented material is 40 to 60 inches, or the subsoil is very gravelly sandy loam.

Included in this unit are small areas of Cinebar, Nargar, Norma, Ogarty, Persis, and Ragnar soils, poorly drained soils in depressions, and Klaus soils that have slopes of more than 15 percent or less than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Klaus soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent is western redcedar. The common forest understory plants are salal, western swordfern, red huckleberry, vine maple, Oregongrape, deer fern, longtube twinflower, trailing blackberry, and creambush oceanspray.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 142. On the basis of a 50-year site curve, it is 111. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 148 cubic feet per acre per year, occurring at age 65. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting

depth is restricted by the lower part of the substratum, which is iron cemented, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

113—Klaus sandy loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on terraces. It formed in a mixture of volcanic ash and alluvium over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 700 to 1,400 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 155 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2.5 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown sandy loam. The upper 9 inches of the subsoil is dark brown gravelly sandy loam. The lower 12 inches is brown very gravelly sand. Iron-cemented, brown extremely gravelly sand is at a depth of about 28 inches. The depth to iron-cemented material ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, the depth to iron-cemented material is 40 to 60 inches, or the subsoil is very gravelly sandy loam.

Included in this unit are small areas of Cinebar, Nargar, Norma, Ogarty, Persis, and Ragnar soils and Klaus soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Klaus soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent is western redcedar. The common forest understory plants are salal, western swordfern, red huckleberry, vine maple, Oregongrape, deer fern, longtube twinflower, trailing blackberry, and creambush oceanspray.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 142. On the basis of a 50-year site curve, it is 111. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 148 cubic feet per acre per year, occurring at age 65. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and the using cable systems that lift logs entirely off the ground can reduce the degree of compaction and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of planted Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the lower part of the substratum, which is iron cemented, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

114—Klaus sandy loam, windswept, 0 to 8 percent slopes. This moderately deep, well drained soil is on terraces. It formed in a mixture of volcanic ash and alluvium over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 700 to 1,400 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 155 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2.5 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown sandy loam. The upper 9 inches of the subsoil is dark brown gravelly sandy loam. The lower 12 inches is brown very gravelly sand. Iron-cemented, brown extremely gravelly sand is at a depth of about 28 inches. The depth to iron-cemented material ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loam. In other areas the soil has less than 35 percent rock

fragments in the subsoil, the depth to iron-cemented material is 40 to 60 inches, or the subsoil is very gravelly sandy loam.

Included in this unit are small areas of Cinebar, Nargar, Norma, Ogarty, Persis, and Ragnar soils, poorly drained soils in depressions, and Klaus soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Klaus soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used as a source of aggregate.

Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent is western redcedar. The common forest understory plants are salal, western swordfern, red huckleberry, vine maple, Oregongrape, deer fern, longtube twinflower, trailing blackberry, and creambush oceanspray.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 122. On the basis of a 50-year site curve, it is 92. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 118 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the lower part of the substratum, which is iron cemented, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

115—Klaus sandy loam, windswept, 30 to 65 percent slopes. This moderately deep, well drained soil is on terraces. It formed in a mixture of volcanic ash and alluvium over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 700 to 1,400 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 155 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2.5 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown sandy loam. The upper 9 inches of the subsoil is dark brown gravelly sandy loam. The lower 12 inches is brown very gravelly sand. Iron-cemented, brown extremely gravelly sand is at a depth of about 28 inches. The depth to iron-cemented material ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, the depth to iron-cemented material is 40 to 60 inches, or the subsoil is very gravelly sandy loam.

Included in this unit are small areas of Cinebar, Nargar, Norma, Ogarty, Persis, and Ragnar soils and Klaus soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Klaus soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent is western redcedar. The common forest understory plants are salal, western swordfern, red huckleberry, vine maple, Oregongrape, deer fern, longtube twinflower, trailing blackberry, and creambush oceanspray.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 122. On the basis of a 50-year site curve, it is 92. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 118 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western

hemlock have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of planted Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the lower part of the substratum, which is iron cemented, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

116—Larrupin loamy sand, 3 to 30 percent slopes. This very deep, well drained soil is on valley bottoms and the adjacent mountain back slopes. It formed in volcanic ash and pumice over volcanic mudflow. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. The surface layer is dark brown loamy sand 6 inches thick. The upper 18 inches of the subsoil is dark yellowish brown gravelly loamy sand. The lower 11 inches is dark yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown very gravelly sandy loam. In some areas the surface layer is gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Lemolo, Littlejohn, and Pitcher soils and Larrupin soils that have slopes of more than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Larrupin soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are salal, Oregongrape, vine maple, red huckleberry, western swordfern, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 118. On the basis of a 50-year site curve, it is 95. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 111 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established

seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs occasionally. Seedlings that are planted or naturally established in the less fertile upper part of the subsoil grow poorly and lack vigor.

This unit is in capability subclass IVe.

117—Larrupin loamy sand, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice over volcanic mudflow. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. The surface layer is dark brown loamy sand 6 inches thick. The upper 18 inches of the subsoil is dark yellowish brown gravelly sandy loam. The lower 11 inches is dark yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown very gravelly sandy loam. In some areas the surface layer is gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Lemolo, Littlejohn, and Pitcher soils and Larrupin soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Larrupin soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are salal, Oregongrape, vine maple, red huckleberry, western swordfern, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 118. On the basis of a 50-year site curve, it is 95. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 111 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. During an average year, snowpack limits the use of equipment and restricts access from January through March. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs occasionally. Seedlings that are planted or naturally established in the less fertile upper part of the subsoil grow poorly and lack vigor.

This unit is in capability subclass VIIe.

118—Larrupin loamy sand, hard substratum, 6 to 30 percent slopes. This deep, well drained soil is on glacially modified mountain back slopes. It formed in volcanic ash and cinders, which are underlain by andesitic block-and-ash flow from Mount Rainier and by dense lahar. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and moss 3 inches thick. The surface layer is dark brown loamy sand 6 inches thick. The upper 11 inches of the subsoil is variegated brown, strong brown, and light gray cindery loamy sand. The lower 18 inches is dark yellowish brown very gravelly loam. The upper 17 inches of the substratum is yellowish brown very cobbly loam. Dark grayish brown, dense lahar that crushes to extremely gravelly sand is at a depth of about 52 inches. The depth to lahar ranges from 40 to 60 inches. The dense lahar is similar to a cemented pan. In some areas the surface layer is cindery loamy sand or cindery sandy loam. In other areas the dense lahar is below a depth of 60 inches.

Included in this unit are small areas of Jonas, Rugles, and Zynbar soils and Larrupin soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Larrupin soil and very slow in the dense lahar. Available water capacity is moderate. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Douglas fir, Pacific silver fir, red alder, and western redcedar. The common forest understory plants are salal, Oregongrape, western swordfern, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index for western hemlock is 151. On the basis of a 50-year site curve, it is 105. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 240 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

119—Lemolo silt loam, 0 to 8 percent slopes. This very deep, poorly drained soil is on terraces. It formed in Osceola mudflow. The native vegetation is mainly conifers and shrubs. Elevation is 750 to 1,600 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 180 days.

Typically, the surface is covered with a mat of organic material 6 inches thick. The surface layer is black silt loam 5 inches thick. The subsoil is very dark gray, mottled loam 12 inches thick. The upper 17 inches of the substratum is grayish brown, mottled very gravelly sandy clay loam. The lower part to a depth of 60 inches is gray, mottled very gravelly sandy clay loam. In some areas the surface layer is loam. In other areas the substratum has more than 30 percent clay or has 15 to 50 percent rock fragments.

Included in this unit are small areas of Ohop soils and organic soils. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Lemolo soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is within a depth of 1 foot from November through May. Runoff generally is slow but can be ponded during the winter months. The hazard of water erosion is slight. This soil is subject to rare flooding.

This unit is used as woodland. Western hemlock and red alder are the main woodland species. Among the trees of limited extent are Douglas fir, Sitka spruce, and western redcedar. The common forest understory plants are western swordfern, salal, devilsclub, red huckleberry, vine maple, salmonberry, trailing blackberry, and thimbleberry.

On the basis of a 100-year site curve, the mean site index is 158 for western hemlock. On the basis of a 50-year site curve, it is 113 for western hemlock and 90 for red alder. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 251 cubic feet per acre per year, occurring at age 50. For red alder it is 101 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are occasional snowpack and the muddiness caused by seasonal wetness. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment

can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Lowering the water table by installing an effective drainage system increases the productivity of Douglas fir. When the surface layer is removed by harvesting activities, seedlings planted in the less fertile underlying material grow poorly and lack vigor. Reforestation can be accomplished by planting western hemlock or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder and western redcedar occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIw.

120—Littlejohn gravelly sandy loam, 8 to 30 percent slopes. This well drained soil is on mountain back slopes and ridges. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and pumice over residuum and colluvium derived from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark yellowish brown gravelly sandy loam 11 inches thick. The subsoil is dark yellowish brown very gravelly loam 6 inches thick. The substratum is olive brown very gravelly loam 13 inches thick. Fractured andesite is at a depth of about 30 inches. The depth to andesite ranges from 25 to 40 inches. In some areas the surface layer is cindery loamy sand or gravelly loam. In other areas the soil is 40 to 60 inches deep over bedrock, is moderately well drained, has less than 35 percent rock fragments in the solum or substratum, or is underlain by breccia.

Included in this unit are small areas of Dobbs, Jonas, and Pheeney soils, soils that are 10 to 20 inches deep over bedrock, and Littlejohn soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Littlejohn soil. Available water capacity also is moderate. The effective rooting depth is 25 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir and Pacific silver fir. The common forest understory plants are western swordfern, Oregongrape, vine maple, salal, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 144. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 150 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher

on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

121—Littlejohn gravelly sandy loam, 30 to 65 percent slopes. This well drained soil is on mountain back slopes and ridges. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and pumice over residuum and colluvium derived from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark yellowish brown gravelly sandy loam 11 inches thick. The subsoil is dark yellowish brown very gravelly loam 6 inches thick. The substratum is olive brown very gravelly loam 13 inches thick. Fractured andesite is at a depth of about 30 inches. The depth to andesite ranges from 25 to 40 inches. In some areas the surface layer is cindery loamy sand or gravelly loam. In other areas the soil is 40 to 60 inches deep over bedrock, is moderately well drained, has less than 35 percent rock fragments in the solum or substratum, or is underlain by breccia.

Included in this unit are small areas of Dobbs, Jonas, and Pheeney soils, soils that are 10 to 20 inches deep over bedrock, and Littlejohn soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Littlejohn soil. Available water capacity also is moderate. The effective rooting depth is 25 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir and Pacific silver fir. The common forest understory plants are western swordfern, Oregongrape, vine maple, salal, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 144. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 150 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock,

trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

122—Littlejohn gravelly sandy loam, windswept, 30 to 65 percent slopes. This well drained soil is on mountain back slopes and ridges. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and pumice over residuum and colluvium derived from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark yellowish brown gravelly sandy loam 11 inches thick. The subsoil is dark yellowish brown very gravelly loam 6 inches thick. The substratum is olive brown very gravelly loam 13 inches thick. Fractured andesite is at a depth of about 30 inches. The depth to andesite ranges from 25 to 40 inches. In some areas the surface layer is cindery loamy sand or gravelly loam. In other areas the soil is 40 to 60 inches deep over bedrock, is moderately well drained, has less than 35 percent rock fragments in the solum or substratum, or is underlain by breccia.

Included in this unit are small areas of Dobbs, Jonas, and Pheeney soils, soils that are 10 to 20 inches deep over bedrock, and Littlejohn soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Littlejohn soil. Available water capacity also is moderate. The effective rooting depth is 25 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir and Pacific silver fir. The common forest understory plants are western swordfern, Oregongrape, vine maple, salal, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 117. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

123—Littlejohn gravelly sandy loam, tuff substratum, 8 to 30 percent slopes. This well drained soil is on mountain back slopes and ridges. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and pumice over residuum and colluvium

derived from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark yellowish brown gravelly sandy loam 7 inches thick. The upper 6 inches of the subsoil is olive brown gravelly sandy loam. The lower 5 inches is dark yellowish brown very gravelly sandy loam. The substratum also is dark yellowish brown very gravelly sandy loam. It is 9 inches thick. Fractured breccia is at a depth of about 27 inches. The depth to breccia ranges from 25 to 40 inches. In some areas the surface layer is cindery loamy sand or gravelly loam. In other areas the soil is 40 to 60 inches deep over bedrock, is moderately well drained, has less than 35 percent rock fragments in the solum or substratum, or is underlain by andesite.

Included in this unit are small areas of Dobbs, Jonas, and Pheeney soils, soils that are 10 to 20 inches deep over bedrock, and Littlejohn soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Littlejohn soil. Available water capacity is low. The effective rooting depth is 25 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir and Pacific silver fir. The common forest understory plants are western swordfern, Oregongrape, vine maple, salal, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 144. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 150 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

124—Littlejohn gravelly sandy loam, tuff substratum, 30 to 65 percent slopes. This well drained soil is on mountain back slopes and ridges. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and pumice over residuum and colluvium derived from breccia. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark yellowish brown gravelly sandy loam 7 inches thick. The upper 6 inches of the subsoil is olive brown gravelly sandy loam. The lower 5 inches is dark

yellowish brown very gravelly sandy loam. The substratum also is dark yellowish brown very gravelly sandy loam. It is 9 inches thick. Fractured breccia is at a depth of about 27 inches. The depth to breccia ranges from 25 to 40 inches. In some areas the surface layer is cindery loamy sand or gravelly loam. In other areas the soil is 40 to 60 inches deep over bedrock, is moderately well drained, has less than 35 percent rock fragments in the solum or substratum, or is underlain by andesite.

Included in this unit are small areas of Dobbs, Jonas, and Pheeney soils, soils that are 10 to 20 inches deep over bedrock, and Littlejohn soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Littlejohn soil. Available water capacity is low. The effective rooting depth is 25 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir and Pacific silver fir. The common forest understory plants are western swordfern, Oregongrape, vine maple, salal, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 144. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 150 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

125—Littlejohn gravelly sandy loam, tuff substratum, windswept, 30 to 65 percent slopes. This well drained soil is on mountain back slopes and ridges. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and pumice over residuum and colluvium derived from tuff and breccia. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark yellowish brown gravelly sandy loam 11 inches thick. The upper 6 inches of the subsoil is olive brown very gravelly sandy loam. The lower 6 inches is dark yellowish brown very gravelly sandy loam. The substratum also is dark yellowish brown very gravelly sandy loam. It is 7 inches thick. Fractured breccia is at a depth of about 30 inches. The depth to breccia ranges from 25 to 40 inches. In some areas the surface layer is cindery loamy sand or gravelly loam. In other areas the soil is 40 to 60 inches deep over bedrock, is

moderately well drained, has less than 35 percent rock fragments in the solum or substratum, or is underlain by andesite.

Included in this unit are small areas of Dobbs, Jonas, and Pheeney soils, soils that are 10 to 20 inches deep over bedrock, and Littlejohn soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Littlejohn soil. Available water capacity is low. The effective rooting depth is 25 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir and Pacific silver fir. The common forest understory plants are western swordfern, Oregongrape, vine maple, salal, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 117. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

126—Littlejohn-Rock outcrop complex, 30 to 90 percent slopes. This map unit is on glacially modified mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 160 days.

This unit is 50 percent Littlejohn gravelly sandy loam and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Dobbs, Jonas, and Pheeney soils, talus, soils that are 10 to 20 inches deep over bedrock, and Littlejohn soils that have slopes of less than 30 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Littlejohn soil is moderately deep to bedrock and is well drained. It formed in a mixture of volcanic ash and pumice over residuum and colluvium derived dominantly from igneous rocks. Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark yellowish brown gravelly sandy loam 11 inches thick. The subsoil is dark yellowish brown very gravelly loam 6 inches thick. The substratum is olive brown very gravelly loam 13 inches

thick. Fractured bedrock is at a depth of about 30 inches. The depth to bedrock ranges from 25 to 40 inches. In some areas the surface layer is cindery loamy sand or gravelly loam. In other areas the soil is 40 to 60 inches deep over bedrock, is moderately well drained, or has less than 35 percent rock fragments in the solum or substratum.

Permeability is moderate in the Littlejohn soil. Available water capacity is low. The effective rooting depth is 25 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

Typically, the Rock outcrop is igneous rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir and Pacific silver fir. The common forest understory plants are western swordfern, Oregongrape, vine maple, salal, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 144. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 150 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. Yields are reduced by the Rock outcrop, which makes up about 30 percent of this unit.

The main limitations affecting timber harvesting are the Rock outcrop, the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Littlejohn soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

127—Lynnwood loamy fine sand, 6 to 15 percent slopes. This very deep, somewhat excessively drained soil is on outwash terraces. It formed in glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 49 degrees F. The average frost-free period is about 190 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown loamy fine sand. The upper 15 inches of the subsoil is dark yellowish brown loamy fine sand. The lower 5 inches is olive brown fine sand. The substratum to a depth of 60 inches is olive fine sand. In some areas the surface layer is sandy loam or loam. In other areas the soil has 15 to 25 percent pebbles in the substratum or is 14 to 24 inches deep to loamy sand or sand.

Included in this unit are small areas of Barneston,

Neilton, and Ragnar soils and Lynnwood soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is rapid in the Lynnwood soil. Available water capacity is moderate. The effective rooting depth is 60 inches or more. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used as pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used as woodland, hayland, or pasture. In the areas used for hay and pasture, the main limitations are the moderate available water capacity and the slope.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, and western redcedar. The common forest understory plants are western swordfern, brackenfern, ladyfern, deer fern, red huckleberry, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 154. On the basis of a 50-year site curve, it is 121. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 163 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVs.

128—Marblemount gravelly loamy sand, 8 to 30 percent slopes. This moderately deep, well drained soil is on glacially modified mountain back slopes. It formed in a mixture of volcanic ash, glacial till, and colluvium derived dominantly from granite and low-grade metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of organic material 2 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown gravelly loamy sand. The upper 17 inches of the subsoil is variegated reddish brown and strong brown very gravelly loamy sand. The lower 13 inches is brown extremely gravelly loamy sand. Fractured granite is at a depth of about 35 inches. The depth to granite or metamorphic rocks ranges from 20 to 40 inches. In some areas the surface layer is loamy sand. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Philippa soils, soils that are 10 to 20 inches deep over bedrock, and Marblemount soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Marblemount soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common forest understory plants are western swordfern, salal, Pacific trillium, Oregongrape, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index is 117 for western hemlock and 129 for Douglas fir. On the basis of a 50-year site curve, it is 85 for western hemlock and 107 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 174 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 128 cubic feet per acre per year, occurring at age 70.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because

most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting western hemlock, Douglas fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

129—Marblemount gravelly loamy sand, 30 to 65 percent slopes. This moderately deep, well drained soil is on glacially modified mountain back slopes. It formed in a mixture of volcanic ash, glacial till, and colluvium derived dominantly from granite and low-grade metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of organic material 2 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown gravelly loamy sand. The upper 17 inches of the subsoil is variegated reddish brown and strong brown very gravelly loamy sand. The lower 13 inches is brown extremely gravelly loamy sand. Fractured granite is at a depth of about 35 inches. The depth to granite or metamorphic rocks ranges from 20 to 40 inches. In some areas the surface layer is loamy sand. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Philippa soils, soils that are 10 to 20 inches deep over bedrock, and Marblemount soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Marblemount soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common forest understory plants are western swordfern, salal, Pacific trillium, Oregongrape, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index is 117 for western hemlock and 129 for Douglas fir. On the basis of a 50-year site curve, it is 85 for western hemlock and 107 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 174 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 128 cubic feet per acre per year, occurring at age 70.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and

naturally established seedlings. Reforestation can be accomplished by planting western hemlock, Douglas fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

130—Marblemount gravelly loamy sand, schist substratum, 30 to 65 percent slopes. This moderately deep, well drained soil is on glacially modified mountain back slopes. It formed in a mixture of volcanic ash, glacial till, and colluvium derived dominantly from schist. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of organic material 5 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown gravelly loamy sand. The subsoil is dark brown very gravelly loamy sand 9 inches thick. The substratum is 22 inches of variegated very gravelly and extremely gravelly loamy sand. Weathered schist is at a depth of about 38 inches. The depth to weathered schist ranges from 20 to 40 inches. In some areas the surface layer is loamy sand. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Philippa soils, soils that are 10 to 20 inches deep over bedrock, and Marblemount soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid in the Marblemount soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common forest understory plants are western swordfern, salal, Pacific trillium, Oregongrape, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index is 117 for western hemlock and 129 for Douglas fir. On the basis of a 50-year site curve, it is 85 for western hemlock and 107 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 174 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 128 cubic feet per acre per year, occurring at age 70.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality schist. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting western hemlock, Douglas fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIs.

131—Marblemount-Rock outcrop complex, 45 to 90 percent slopes. This map unit is on glacially modified mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 120 days.

This unit is 50 percent Marblemount gravelly loamy sand and 40 percent Rock outcrop. The components of

this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Philippa soils, talus, soils that are 10 to 20 inches deep over bedrock, and Marblemount soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Marblemount soil is moderately deep and well drained. It formed in a mixture of volcanic ash, glacial till, and colluvium derived dominantly from granite and low-grade metamorphic rocks. Typically, the surface is covered with a mat of organic material 2 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown gravelly loamy sand. The upper 17 inches of the subsoil is variegated reddish brown and strong brown very gravelly loamy sand. The lower 13 inches is brown extremely gravelly loamy sand. Fractured granite is at a depth of about 35 inches. The depth to granite or metamorphic rocks ranges from 20 to 40 inches. In some areas the surface layer is loamy sand. In other areas the soil is 40 to 60 inches deep over bedrock.

Permeability is moderately rapid in the Marblemount soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is granite or low-grade metamorphic rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common forest understory plants are western swordfern, salal, Pacific trillium, Oregongrape, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index is 117 for western hemlock and 129 for Douglas fir. On the basis of a 50-year site curve, it is 85 for western hemlock and 107 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 174 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 128 cubic feet per acre per year, occurring at age 70. Yields are reduced by the Rock outcrop, which makes up about 40 percent of this unit.

The main limitations affecting timber harvesting are the occasional snowpack, the Rock outcrop, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite or metamorphic rock. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting western hemlock, Douglas fir, or Pacific silver fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Marblemount soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

132—Mashel silt loam, 5 to 30 percent slopes. This very deep, moderately well drained soil is on back slopes in the foothills. It formed in glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 700 to 1,800 feet. The average annual precipitation is about 55 inches, and the average annual air

temperature is about 49 degrees F. The average frost-free period is about 190 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark grayish brown silt loam 7 inches thick. The upper 6 inches of the subsoil is brown silt loam. The next 17 inches is brown silty clay loam and silty clay. The lower part to a depth of 60 inches is grayish brown silty clay. In some areas the surface layer is loam, gravelly loam, or gravelly silt loam. In other areas the subsoil has 15 to 35 percent rock fragments and 10 to 18 percent clay throughout or has 18 to 35 percent clay in the lower part.

Included in this unit are small areas of Cinebar, Scamman, and Wilkeson soils and Mashel soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Mashel soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and red alder are the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and bigleaf maple. The common forest understory plants are vine maple, Oregon oxalis, western swordfern, longtube twinflower, western brackenfern, blackberry, and red huckleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 162. On the basis of a 50-year site curve, it is 123. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 172 cubic feet per acre per year, occurring at age 65. Estimates of the site index and growth rate of red alder have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

133—Mashel silt loam, 30 to 65 percent slopes. This very deep, moderately well drained soil is on back slopes in the foothills. It formed in glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 700 to 1,800 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 49 degrees F. The average frost-free period is about 190 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark grayish brown silt loam 7 inches thick. The upper 6 inches of the subsoil is brown silt loam. The next 17 inches is brown silty clay loam and silty clay. The lower part to a depth of 60 inches is grayish brown silty clay. In some areas the surface layer is loam, gravelly loam, or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, has 10 to 18 percent clay in the subsoil, or has 18 to 35 percent clay in the lower part of the substratum.

Included in this unit are small areas of Cinebar, Scamman, and Wilkeson soils and Mashel soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Mashel soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and red alder are the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and bigleaf maple. The common forest understory plants are vine maple, Oregon oxalis, western swordfern, longtube twinflower, western brackenfern, blackberry, and red huckleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 162. On the basis of a 50-year site curve, it is 123. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 172

cubic feet per acre per year, occurring at age 65. Estimates of the site index and growth rate of red alder have not been made.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

134—Melakwa sandy loam, 8 to 30 percent slopes. This moderately deep, well drained soil is on glacially modified mountain back slopes and toe slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown sandy loam. The upper 15 inches of the subsoil is dark brown and dark yellowish brown very gravelly sandy loam. The lower 9 inches is olive brown very gravelly loam. The substratum is light olive brown extremely gravelly loam 6 inches thick. Hard, fractured andesite is at a depth of about 37 inches. The depth to fractured andesite ranges from 20 to 40 inches. In some areas the soil has a substratum of loamy sand, is 40 to 60 inches deep over bedrock, is underlain by breccia, or has 15 to 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Kaleetan, Littlejohn, Marblemount, Philippa, and Pitcher soils, poorly drained soils in depressions, and Melakwa soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Melakwa soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are western swordfern, Oregongrape, salal, vine maple, red huckleberry, Pacific trillium, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 128. On the basis of a 50-year site curve, it is 104. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 127 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production.

Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

135—Melakwa sandy loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on glacially modified mountain back slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown sandy loam. The upper 15 inches of the subsoil is dark brown and dark yellowish brown very gravelly sandy loam. The lower 9 inches is olive brown very gravelly loam. The substratum is light olive brown extremely gravelly loam 6 inches thick. Hard, fractured andesite is at a depth of about 37 inches. The depth to fractured andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil has a substratum of loamy sand, is 40 to 60 inches deep over bedrock, is underlain by breccia, or has 15 to 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Kaleetan, Littlejohn, Marblemount, Philippa, and Pitcher soils and Melakwa soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Melakwa soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are western swordfern, Oregongrape, salal, vine maple, red huckleberry, Pacific trillium, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 128. On the basis of a 50-year site curve, it is 104. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 127 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

136—Melakwa sandy loam, windswept, 30 to 65 percent slopes. This moderately deep, well drained soil is on glacially modified mountain back slopes and toe

slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown sandy loam. The upper 15 inches of the subsoil is dark brown and dark yellowish brown very gravelly sandy loam. The lower 9 inches is olive brown very gravelly loam. The substratum is light olive brown extremely gravelly loam 6 inches thick. Hard, fractured andesite is at a depth of about 37 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil has a substratum of loamy sand, is 40 to 60 inches deep over bedrock, is underlain by breccia, or has 15 to 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Kaleetan, Littlejohn, Marblemount, Philippa, and Pitcher soils and Melakwa soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Melakwa soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are western swordfern, Oregongrape, salal, vine maple, red huckleberry, Pacific trillium, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 117. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

137—Melakwa sandy loam, tuff substratum, 30 to 65 percent slopes. This moderately deep, well drained soil is on glacially modified mountain back slopes and toe slopes. It formed in a mixture of volcanic ash and pumice over colluvium derived from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown sandy loam. The upper 10 inches of the subsoil is dark yellowish brown very gravelly loam. The lower 13 inches is olive brown very gravelly loam. Hard breccia is at a depth of about 31 inches. The depth to breccia ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil has a

substratum of loamy sand, is 40 to 60 inches deep over bedrock, is underlain by andesite, or has 15 to 35 percent rock fragments in the solum or substratum.

Included in this unit are small areas of Kaleetan, Littlejohn, Marblemount, Philippa, and Pitcher soils and Melakwa soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Melakwa soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are western swordfern, Oregongrape, salal, vine maple, red huckleberry, Pacific trillium, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 128. On the basis of a 50-year site curve, it is 104. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 127 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

138—Melakwa-Rock outcrop complex, 45 to 90 percent slopes. This map unit is on glacially modified mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

This unit is 50 percent Melakwa sandy loam and 40 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Kaleetan, Littlejohn, Marblemount, Philippa, and Pitcher soils, talus, soils that are 10 to 20 inches deep over bedrock, and Melakwa soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Melakwa soil is moderately deep and well drained. It formed in a mixture of volcanic ash and pumice over colluvium derived from andesite. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown sandy loam. The upper 15 inches of the subsoil is dark brown and dark yellowish brown very gravelly sandy loam. The lower 9 inches is olive brown very gravelly loam. The substratum is light olive brown extremely gravelly loam 6 inches thick. Hard, fractured andesite is at a depth of about 37 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, gravelly sandy loam, or gravelly loamy sand. In other areas the soil has a substratum of loamy sand, is 40 to 60 inches deep over bedrock, is underlain by

breccia, or has 15 to 35 percent rock fragments in the solum or substratum.

Permeability is moderate in the Melakwa soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

Typically, the Rock outcrop is andesite. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are western swordfern, Oregongrape, salal, vine maple, red huckleberry, Pacific trillium, deer fern, longtube twinflower, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 128. On the basis of a 50-year site curve, it is 104. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 127 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of western hemlock have not been made. Yields are reduced by the Rock outcrop, which makes up about 40 percent of this unit.

The main limitations affecting timber harvesting are the Rock outcrop, the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Melakwa soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

139—Mowich silt loam, 0 to 15 percent slopes. This very deep, somewhat poorly drained soil is on proglacial lake plains. It formed in volcanic ash over glaciolacustrine sediments. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of organic material 8 inches thick. The surface layer is dark brown silt loam 7 inches thick. The upper 3 inches of the subsoil is strong brown silt loam. The lower 16 inches is dark yellowish brown, mottled silt loam. The substratum to a depth of 60 inches is light brownish gray, mottled silty clay. Depth to the substratum ranges from 20 to 35 inches. In some areas the surface layer is loam. In other areas the soil has 30 to 45 percent clay in the substratum or is 10 to 20 inches deep to the substratum.

Included in this unit are small areas of Pierking soils and organic soils. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Mowich soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a

depth of 1 to 2 feet from November through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are salal, western swordfern, Oregongrape, red huckleberry, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 156. On the basis of a 50-year site curve, it is 121. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 165 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are occasional snowpack and the muddiness caused by seasonal wetness. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVw.

140—Mukilteo peat, 0 to 1 percent slopes. This very deep, very poorly drained soil is in bogs. It formed in herbaceous and woody organic material. Areas are oval or elongated and are 5 to 80 acres in size. The native vegetation is mainly shrubs and forbs. Elevation is 600 to 1,000 feet. The average annual precipitation is about 50 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface layer is dark brown peat 10 inches thick. The underlying material to a depth of 60 inches is dark brown and dark reddish brown hemic material. In some areas the surface layer is mucky peat.

Included in this unit are small areas of Norma, Seattle, and Shalcar soils and Barneston, Ogarty, and Tokul soils on the adjacent uplands. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the Mukilteo soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at or above the surface from November through May. Runoff is very slow, and there is no hazard of erosion.

This unit is used for wildlife habitat. The native vegetation includes willows, sedges, cattail, hardhack, and rushes. The unit is unsuited to the production of commercial trees.

This unit is in capability subclass VIIw.

141—Nagrom sandy loam, 8 to 30 percent slopes. This well drained soil is on ridge crests and mountain back slopes. It is moderately deep to fractured bedrock. It formed in volcanic ash and pumice over colluvium and residuum derived dominantly from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,400 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of leaves, needles, twigs, and moss 1.5 inches thick. When mixed to a depth of 4 inches, the surface layer is dark brown sandy loam. The upper 3 inches of the subsoil is dark reddish brown loam. The lower 16 inches is dark yellowish brown very gravelly loam. The substratum is yellowish brown very gravelly loam 15 inches thick. Fractured andesite is at a depth of about 38 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, loam, or gravelly loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Nimue and

Playco soils, soils that are 10 to 20 inches deep to andesite, and Nagrom soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nagrom soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are western swordfern, trillium, huckleberry, salal, deer fern, common beargrass, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 109. On the basis of a 50-year site curve, it is 77. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 158 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

142—Nagrom sandy loam, 30 to 65 percent slopes. This well drained soil is on ridge crests and mountain back slopes. It is moderately deep to fractured bedrock. It formed in volcanic ash and pumice over colluvium and residuum derived dominantly from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,400 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of leaves, needles, twigs, and moss 1.5 inches thick. When mixed to a depth of 4 inches, the surface layer is dark brown sandy loam. The upper 3 inches of the subsoil is dark reddish brown loam. The lower 16 inches is dark yellowish brown very gravelly loam. The substratum is yellowish brown very gravelly loam 15 inches thick. Fractured andesite is at a depth of about 38 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, loam, or gravelly loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Nimue and Playco soils, soils that are 10 to 20 inches deep to andesite, and Nagrom soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nagrom soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are western swordfern, trillium, huckleberry, salal, deer fern, common beargrass, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 109. On the basis of a 50-year site curve, it is 77. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 158 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds

are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

143—Nagrom gravelly loam, tuff substratum, 8 to 30 percent slopes. This well drained soil is on ridge crests and mountain back slopes. It is moderately deep to fractured bedrock. It formed in volcanic ash and pumice over colluvium and residuum derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 2,400 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of leaves, needles, twigs, and moss 4 inches thick. The surface layer is very dark brown gravelly loam 4 inches thick. The upper 6 inches of the subsoil is dark brown gravelly loam. The lower 15 inches is strong brown very gravelly sandy loam and dark yellowish brown very gravelly loam. The substratum is yellowish brown extremely gravelly silt loam 9 inches thick. Weathered breccia is at a depth of about 34 inches. The depth to breccia or tuff ranges from 20 to 40 inches. In some areas the surface layer is sandy loam or loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil, is 40 to 60 inches deep to breccia or tuff, or is underlain by andesite.

Included in this unit are small areas of Nimue and Playco soils, soils that are 10 to 20 inches deep to breccia or tuff, and Nagrom soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nagrom soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are western swordfern, trillium, huckleberry, salal, deer fern, common beargrass, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 126. On the basis of a 50-year site curve, it is 90. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 192 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill

slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

144—Nagrom gravelly loam, tuff substratum, 30 to 65 percent slopes. This well drained soil is on ridge crests and mountain back slopes. It is moderately deep to fractured bedrock. It formed in volcanic ash and pumice over colluvium and residuum derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 2,400 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of leaves, needles, twigs, and moss 4 inches thick. The surface layer is very dark brown gravelly loam 4 inches thick. The upper 6 inches of the subsoil is dark brown gravelly loam. The lower 15 inches is strong brown very gravelly sandy loam and dark yellowish brown very gravelly loam. The substratum is yellowish brown extremely gravelly silt loam 9 inches thick. Weathered breccia is at a depth of about 34 inches. The depth to breccia or tuff ranges from 20 to 40 inches. In some areas the surface layer is sandy loam or loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil, is 40 to 60 inches deep to breccia or tuff, or is underlain by andesite.

Included in this unit are small areas of Nimue and Playco soils, soils that are 10 to 20 inches deep to breccia or tuff, and Nagrom soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nagrom soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are western swordfern, trillium, huckleberry, salal, deer fern, common beargrass, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 126. On the basis of a 50-year site curve, it is 90. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 192 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is

established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

145—Nagrom-Rock outcrop complex, 30 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 2,400 to 3,600 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

This unit is 50 percent Nagrom sandy loam and 40 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Nimue, Playco, and Reggad soils, talus, soils that are 10 to 20 inches deep over bedrock, and Nagrom soils that have slopes of less than 30 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Nagrom soil is moderately deep to fractured bedrock and is well drained. It formed in volcanic ash and pumice over colluvium and residuum derived dominantly from extrusive igneous rocks. Typically, the surface is covered with a mat of leaves, needles, twigs, and moss 1.5 inches thick. When mixed to a depth of 4 inches, the surface layer is dark brown sandy loam. The upper 3 inches of the subsoil is dark reddish brown loam. The lower 16 inches is dark yellowish brown very gravelly loam. The substratum is yellowish brown very gravelly loam 15 inches thick. Fractured andesite is at a depth of about 38 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, loam, or gravelly loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Permeability is moderate in the Nagrom soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is andesite. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are western swordfern, trillium, huckleberry, salal, deer fern, common beargrass, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 109. On the basis of a 50-year site curve, it is 77. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 158 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 40 percent of this unit.

The main limitations affecting timber harvesting are snowpack, the Rock outcrop, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is

established. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Nagrom soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

146—Nargar fine sandy loam, 0 to 15 percent slopes. This very deep, well drained soil is on terraces. It formed in a mixture of volcanic ash and sandy alluvium over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 700 to 1,200 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown fine sandy loam 2 inches thick. The subsoil is strong brown and yellowish brown fine sandy loam 22 inches thick. The substratum to a depth of 60 inches is olive brown sand. In some areas the surface layer is loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Barneston, Lynnwood, and Pastik soils and Nargar soils that have slopes of more than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Nargar soil and rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used for hay or pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used mainly as woodland. It also is used for hay and pasture.

In the areas used for hay and pasture, the main limitations are soil compaction, the hazard of erosion, and the moderate available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, and western redcedar. The common forest understory plants are western swordfern, red huckleberry, ladyfern, vine maple, salal, deer fern, salmonberry, western brackenfern, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 177. On the basis of a 50-year site curve, it is 134. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 188 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Extra rock is needed to maintain a stable and uniform road surface. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist, a high degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIe.

147—Nargar fine sandy loam, 15 to 30 percent slopes. This very deep, well drained soil is on terraces. It formed in a mixture of volcanic ash and sandy alluvium over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 700 to 1,200

feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown fine sandy loam 2 inches thick. The subsoil is strong brown and yellowish brown fine sandy loam 22 inches thick. The substratum to a depth of 60 inches is olive brown sand. In some areas the surface layer is loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Barneston, Lynnwood, and Pastik soils and Nargar soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Nargar soil and rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, and western redcedar. The common forest understory plants are western swordfern, red huckleberry, ladyfern, vine maple, salal, deer fern, salmonberry, western brackenfern, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 177. On the basis of a 50-year site curve, it is 134. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 188 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Extra rock is needed to maintain a stable and uniform road surface. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist, a high degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

148—Nargar-Pastik complex, 35 to 70 percent slopes. This map unit is on terrace escarpments. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,200 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 160 days.

This unit is 45 percent Nargar fine sandy loam and 45 percent Pastik silt loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Barneston, Lynnwood, and Tokul soils and Nargar and Pastik soils that have slopes of more than 70 percent or less than 35 percent. Included areas make up about 10 percent of the total acreage.

The Nargar soil is very deep and well drained. It formed in a mixture of volcanic ash and sandy alluvium over glacial outwash. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown fine sandy loam 2 inches thick. The subsoil is strong brown and yellowish brown fine sandy loam 22 inches thick. The substratum to a depth of 60 inches is olive brown sand. In some areas the surface layer is loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or substratum.

Permeability is moderate in the upper part of the Nargar soil and rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

The Pastik soil is very deep and moderately well drained. It formed in lake sediments and volcanic ash. Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown silt loam 6 inches thick. The upper 6 inches

of the subsoil also is dark brown silt loam. The lower 19 inches is dark yellowish brown and yellowish brown very fine sandy loam. The substratum to a depth of 60 inches is olive brown and light brownish gray very fine sandy loam. In some areas the surface layer is sandy loam or loam. In other areas the substratum is silty clay.

Permeability is slow in the Pastik soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 2.5 feet from December through May. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, red huckleberry, ladyfern, vine maple, salal, deer fern, salmonberry, western brackenfern, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 177 on both soils. On the basis of a 50-year site curve, it is 134 on the Nargar soil and 132 on the Pastik soil. On the basis of a 100-year site curve, the mean site index for western hemlock on the Pastik soil is 176. On the basis of a 50-year site curve, it is 123. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 188 cubic feet per acre per year, occurring at age 60 on both soils. For western hemlock it is 285 cubic feet per acre per year, occurring at age 50 on the Pastik soil.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soils are moist, a high degree of puddling when the soils are wet, and a moderate degree of soil displacement when the soils are dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table in the Pastik soil, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

149—National cindery sandy loam, 0 to 8 percent slopes. This very deep, well drained soil is on terraces. It formed in a mixture of volcanic ash and pumice over alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 1,200 to 1,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 165 days.

Typically, the surface is covered with a mat of leaves and twigs 2 inches thick. The surface layer is very dark grayish brown cindery sandy loam 10 inches thick. The upper 18 inches of the subsoil is dark brown and dark yellowish brown very cindery loamy sand. The lower 18 inches is dark yellowish brown loam. The substratum to a depth of 60 inches is dark yellowish brown silt loam. In some areas the surface layer is very cindery sandy loam or cindery loamy sand. In other areas the soil has 15 to 50 percent rock fragments in the lower part of the subsoil and in the substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Greenwater soils and National soils that have slopes of more than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is rapid in the upper part of the National soil and moderate in the lower part of the subsoil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 5 to 6 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. If irrigated, it also is suitable as pasture and hayland.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, red alder, and black cottonwood. The common forest understory plants are Oregon oxalis,

western brackenfern, western swordfern, trailing blackberry, red huckleberry, bedstraw, vine maple, Pacific trillium, and cascade Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 164. On the basis of a 50-year site curve, it is 127. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 174 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir and red alder occurs readily. Seedlings that are planted or naturally established in the less fertile upper part of the subsoil grow poorly and lack vigor. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

This unit is in capability subclass IIIe.

150—Neilton gravelly loamy sand, 2 to 15 percent slopes. This very deep, excessively drained soil is on terraces. It formed in glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 500 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is very dark brown gravelly loamy sand 2 inches thick. The upper 14 inches of the subsoil is dark yellowish brown gravelly loamy sand. The lower 5 inches is dark brown extremely gravelly sand. The substratum to a depth of 60 inches is dark brown very gravelly sand. The depth to very gravelly sand ranges from 15 to 25 inches. In some areas the surface layer is very gravelly loamy sand.

Included in this unit are small areas of Alderwood, Lynnwood, and Norma soils and Neilton soils that have slopes of more than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the Neilton soil. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture. In the areas used for hay and pasture, the main limitation is the low available water capacity. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are grand fir, western hemlock, and western redcedar. The common forest understory plants are Oregongrape, western brackenfern, salal, princes pine, western swordfern, trailing blackberry, red huckleberry, creambush oceanspray, and northern twinflower.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 141. On the basis of a 50-year site curve, it is estimated to be 105. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 146 cubic feet per acre per year, occurring at age 65.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from

unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of planted Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIs.

151—Nimue loamy sand, 6 to 30 percent slopes. This very deep, well drained soil is on rounded ridgetops and mountain back slopes. It formed in a thin mantle of volcanic ash and pumice over colluvium and material weathered from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 5,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown loamy sand. The upper 5 inches of the subsoil is reddish brown and strong brown sandy loam. The lower 14 inches is brown very gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown and olive brown extremely gravelly silt loam. In some areas the surface layer is sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Foss, Haywire, and Playco soils and Nimue soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nimue soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are salal, western swordfern, Oregongrape, Pacific yew, common beargrass, red huckleberry, dwarf huckleberry, and woodrush.

On the basis of a 100-year site curve, the mean site index for western hemlock is 101. On the basis of a 50-year site curve, it is 71. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIe.

152—Nimue loamy sand, 30 to 65 percent slopes. This very deep, well drained soil is on rounded ridgetops and mountain back slopes. It formed in a thin mantle of volcanic ash and pumice over colluvium and material weathered from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 5,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The

average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown loamy sand. The upper 5 inches of the subsoil is reddish brown and strong brown sandy loam. The lower 14 inches is brown very gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown and olive brown extremely gravelly silt loam. In some areas the surface layer is sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Foss, Haywire, and Playco soils and Nimue soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nimue soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are salal, western swordfern, Oregongrape, Pacific yew, common beargrass, red huckleberry, dwarf huckleberry, and woodrush.

On the basis of a 100-year site curve, the mean site index for western hemlock is 101. On the basis of a 50-year site curve, it is 71. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIIe.

153—Nimue loamy sand, 65 to 90 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in a thin mantle of volcanic ash and pumice over colluvium and material weathered from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 5,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown loamy sand. The upper 5 inches of the subsoil is reddish brown and strong brown sandy loam. The lower 14 inches is brown very gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown and olive brown extremely gravelly silt loam. In some areas the surface layer is sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Foss, Haywire, and Playco soils and Nimue soils that have slopes of less than 65 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nimue soil. Available

water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are salal, western swordfern, Oregongrape, Pacific yew, common beargrass, red huckleberry, dwarf huckleberry, and woodrush.

On the basis of a 100-year site curve, the mean site index for western hemlock is 101. On the basis of a 50-year site curve, it is 71. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIIe.

154—Nimue loamy sand, tuff substratum, 8 to 30 percent slopes. This very deep, well drained soil is on rounded ridgetops and mountain back slopes. It formed in a thin mantle of volcanic ash and pumice over colluvium and material weathered from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 5,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown loamy sand. The upper 9 inches of the subsoil is dark yellowish brown sandy loam. The lower 10 inches is dark brown very gravelly sandy loam. The upper 7 inches of the substratum is strong brown very gravelly loam. The lower part to a depth of 60 inches is yellowish brown extremely gravelly loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil, is 40 to 60 inches deep to breccia or tuff, or is underlain by andesite.

Included in this unit are small areas of Foss, Haywire, and Playco soils and Nimue soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nimue soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are salal, western swordfern, Oregongrape, Pacific yew, common beargrass, red huckleberry, dwarf huckleberry, and woodrush.

On the basis of a 100-year site curve, the mean site index for western hemlock is 101. On the basis of a 50-year site curve, it is 71. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIe.

155—Nimue loamy sand, tuff substratum, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in a thin mantle of volcanic ash and pumice over colluvium and material weathered from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 5,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown loamy sand. The upper 9 inches of the subsoil is dark yellowish brown sandy loam. The lower 10 inches is dark brown very gravelly sandy loam. The upper 7 inches of the substratum is strong brown very gravelly loam. The lower part to a depth of 60 inches is yellowish brown extremely gravelly loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil, is 40 to 60 inches deep to breccia or tuff, or is underlain by andesite.

Included in this unit are small areas of Foss, Haywire, and Playco soils and Nimue soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nimue soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are salal, western swordfern, Oregongrape, Pacific yew, common beargrass, red huckleberry, dwarf huckleberry, and woodrush.

On the basis of a 100-year site curve, the mean site index for western hemlock is 101. On the basis of a 50-year site curve, it is 71. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is

dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIIe.

156—Nimue-Rock outcrop complex, 30 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 5,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 120 days.

This unit is 60 percent Nimue loamy sand and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Foss, Haywire, and Playco soils, talus, soils that are 10 to 40 inches deep over bedrock, and Nimue soils that have slopes of less than 30 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Nimue soil is very deep and well drained. It formed in a mantle of volcanic ash and pumice over colluvium and material weathered from extrusive igneous rocks. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 5 inches, the surface layer is dark reddish brown loamy sand. The upper 5 inches of the subsoil is reddish brown and strong brown sandy loam. The lower 14 inches is brown very gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown and olive brown extremely gravelly silt loam. In some areas the surface layer is sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Permeability is moderate in the Nimue soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is andesite. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Alaska cedar. The common forest understory plants are salal, western swordfern, Oregongrape, Pacific yew, common beargrass, red huckleberry, dwarf huckleberry, and woodrush.

On the basis of a 100-year site curve, the mean site index for western hemlock is 101. On the basis of a 50-year site curve, it is 71. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 30 percent of this unit.

The main limitations affecting timber harvesting are snowpack, the Rock outcrop, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation.

The Nimue soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

157—Nooksack silt loam, 0 to 2 percent slopes. This very deep, moderately well drained soil is on flood plains and river terraces. It formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 30 to 500 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 190 days.

Typically, the surface layer is very dark grayish brown silt loam 11 inches thick. The subsoil is dark grayish brown silt loam 18 inches thick. The substratum to a depth of 60 inches is dark grayish brown and grayish brown silt loam. In some areas the surface layer is very fine sandy loam. In other areas the soil has a substratum that is stratified with fine sandy loam and sand, has sand at a depth of 40 to 60 inches, or has less than 50 percent base saturation in the surface layer.

Included in this unit are small areas of Belfast, Oridia, Puget, and Sultan soils and Nooksack soils that have slopes of more than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Nooksack soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3 to 4 feet from February through May. Runoff is very slow, and there is no hazard of erosion. This soil is subject to occasional, brief periods of flooding from November through March.

This unit is used mainly as hayland, pasture, or cropland. It also is used as woodland and as a site for homes.

In the areas used for hay and pasture, the main hazard is the flooding. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition.

The main hazard in the areas used as cropland is the flooding. This unit is suited to all of the crops commonly grown in the survey area. The principal crops are oats and corn silage. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are trailing blackberry, salmonberry, western swordfern, red elderberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 160. On the basis of a 50-year site curve, it is estimated to be 120. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 170 cubic feet per acre per year, occurring at age 65.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and the flooding. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

In the areas used for homesite development, the main limitations are the flooding and the seasonal high water. The seasonal high water table increases the likelihood that septic tank absorption fields will fail. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

This unit is in capability subclass IIIw.

158—Norma loam, 0 to 3 percent slopes. This very deep, poorly drained soil is in depressions on glacial till plains. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is 100 to 800 feet.

The average annual precipitation is about 50 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 180 days.

Typically, the surface layer is very dark grayish brown loam 9 inches thick. The subsoil is dark grayish brown gravelly loam 24 inches thick. The substratum to a depth of 60 inches is dark grayish brown very gravelly sandy loam. In some areas the surface layer is sandy loam or silt loam. In other areas the soil has a sandy substratum, has lenses of sandy material in the subsoil, has 15 to 25 percent clay in the substratum, has 35 to 50 percent pebbles in the subsoil, or has 15 to 35 percent pebbles in the substratum.

Included in this unit are small areas of Alderwood and Lynnwood soils and drained Norma soils. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the Norma soil. Available water capacity is moderate. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from November through May. Runoff is very slow, and there is no hazard of erosion.

This unit is used as woodland, pasture, or hayland. In the areas used for hay and pasture, the main limitations are the seasonal high water table, soil compaction, and puddling. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The water table limits the choice of forage species to grasses and shallow-rooted legumes unless the soil has been drained.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, bigleaf maple, and western hemlock. The common forest understory plants are skunk cabbage, stinging nettle, salmonberry, western swordfern, western brackenfern, trailing blackberry, thimbleberry, salal, Oregongrape, and vine maple.

On the basis of a 50-year site curve, the mean site index for red alder is 90. The highest average growth rate in unmanaged, even-aged stands of red alder is 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist, a high degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIw.

159—Oakes gravelly loam, 6 to 30 percent slopes. This very deep, well drained soil is on glacially modified mountain back slopes and toe slopes. It formed in a mixture of volcanic ash and colluvium and slope alluvium derived from glacial drift. The native vegetation is mainly conifers and shrubs. Elevation is 1,400 to 2,400 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown gravelly loam. The upper 14 inches of the subsoil is dark brown very gravelly loam. The lower 16 inches is dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is light olive brown very gravelly sandy loam. In some areas the surface layer is loam. In other areas the soil has a substratum of loamy sand, is 40 to 60 inches deep to dense glacial till or bedrock, or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Elwell and Skykomish soils and Oakes soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Oakes soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are salal, Oregongrape, western swordfern, western brackenfern, red huckleberry, vine maple, trailing blackberry, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 152 for Douglas fir and 148 for western hemlock. On the basis of a 50-year site curve, it is 117 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 161 cubic feet per acre per year, occurring at age 60. For western hemlock it is 234 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

160—Oakes cobbly loam, 6 to 30 percent slopes. This deep, well drained soil is on mountain toe slopes. It formed in block-and-ash flow deposited over compact lahar or glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,400 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and moss 3 inches thick. The surface layer is dark yellowish brown cobbly loam 6 inches thick. The upper 17 inches of the subsoil is dark yellowish brown very cobbly silt loam. The lower 21 inches is yellowish brown very cobbly silt loam. Yellowish brown, compact lahar that crushes to very gravelly sandy loam is at a depth of about 44 inches. The depth to lahar ranges from 40 to 60 inches. The compact lahar is similar to a cemented pan. In some areas the surface layer is loam or stony loam. In other areas the compact lahar is below a depth of 60 inches.

Included in this unit are small areas of Jonas and Zynbar soils and Oakes soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Oakes soil and very slow in the compact lahar. Available water capacity is moderate. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, Oregongrape, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index is 152 for Douglas fir and 148 for western hemlock. On the basis of a 50-year site curve, it is 117 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 161 cubic feet per acre per year, occurring at age 60. For western hemlock it is 234 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. The cobbles on the surface hinder yarding. When felled, the timber can break on the cobbles. Unsurfaced roads are soft when wet and are subject to deep rutting during

rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. Because of the cobbles, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

161—Oakes cobbly loam, 30 to 65 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in block-and-ash flow deposited over compact lahar or glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,400 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and moss 3 inches thick. The surface layer is dark yellowish brown cobbly loam 6 inches thick. The upper 17 inches of the subsoil is dark yellowish brown very cobbly silt loam. The lower 21 inches is yellowish brown very cobbly silt loam. Yellowish brown, compact lahar that crushes to very gravelly sandy loam is at a depth of about 44 inches. The depth to lahar ranges from 40 to 60 inches. The compact lahar is similar to a cemented pan. In some areas the surface layer is loam or stony loam. In other areas the compact lahar is below a depth of 60 inches.

Included in this unit are small areas of Jonas and Zynbar soils and Oakes soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Oakes soil and very slow in the compact lahar. Available water capacity is moderate. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, Oregongrape, salal, red huckleberry, and vine maple.

On the basis of a 100-year site curve, the mean site index is 152 for Douglas fir and 148 for western hemlock. On the basis of a 50-year site curve, it is 117 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 161 cubic feet per acre per year, occurring at age 60. For western hemlock it is 234 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. The cobbles hinder yarding. When felled, the timber can break on the cobbles. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. Because of the cobbles, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir or red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing

plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

162—Ogarty gravelly loam, 8 to 30 percent slopes. This well drained soil is on back slopes in the foothills. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and colluvium and residuum derived dominantly from andesite and breccia. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1.5 inches thick. The surface layer is very dark grayish brown gravelly loam 4 inches thick. The upper 11 inches of the subsoil is dark brown very gravelly sandy loam. The lower 13 inches is dark yellowish brown and dark brown extremely gravelly fine sandy loam. The substratum is brown extremely gravelly fine sandy loam 9 inches thick. Fractured andesite is at a depth of about 37 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Barneston, Blethen, and Tokul soils and Ogarty soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Ogarty soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, brackenfern, salal, red huckleberry, Oregongrape, vine maple, stinging nettle, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index is 149 for Douglas fir and 169 for western hemlock. On the basis of a 50-year site curve, it is 117 for Douglas fir and 113 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60. For western hemlock it is 272 cubic feet per acre per year, occurring at age 50.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

163—Ogarty gravelly loam, 30 to 65 percent slopes. This well drained soil is on back slopes in the foothills. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and colluvium and residuum derived dominantly from andesite and breccia. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1.5 inches thick. The surface layer is very dark grayish brown gravelly loam 4 inches thick. The upper 11 inches of the subsoil is dark brown very gravelly sandy loam. The lower 13 inches is dark yellowish brown and dark brown extremely gravelly fine

sandy loam. The substratum is brown extremely gravelly fine sandy loam 9 inches thick. Fractured andesite is at a depth of about 37 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Barneston, Blethen, and Tokul soils and Ogarty soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Ogarty soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, brackenfern, salal, red huckleberry, Oregongrape, vine maple, stinging nettle, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index is 149 for Douglas fir and 169 for western hemlock. On the basis of a 50-year site curve, it is 117 for Douglas fir and 113 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60. For western hemlock it is 272 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

164—Ogarty-Rock outcrop complex, 45 to 90 percent slopes. This map unit is on glacially modified back slopes and ridgetops in the foothills. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 160 days.

This unit is 50 percent Ogarty gravelly loam and 40 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Barneston, Blethen, and Tokul soils, soils that are less than 20 inches deep over bedrock, stony areas, and Ogarty soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Ogarty soil is moderately deep to bedrock and is well drained. It formed in a mixture of volcanic ash and colluvium and residuum derived dominantly from andesite and breccia. Typically, the surface is covered with a mat of needles, leaves, and twigs 1.5 inches thick. The surface layer is very dark grayish brown gravelly loam 4 inches thick. The upper 11 inches of the subsoil is dark brown very gravelly sandy loam. The lower 13 inches is dark yellowish brown and dark brown extremely gravelly fine sandy loam. The substratum is brown extremely gravelly fine sandy loam 9 inches thick. Fractured andesite is at a depth of about 37 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Ogarty soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is andesite or breccia. It

is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, brackenfern, salal, red huckleberry, Oregongrape, vine maple, stinging nettle, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index is 149 for Douglas fir and 169 for western hemlock. On the basis of a 50-year site curve, it is 117 for Douglas fir and 113 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60. For western hemlock it is 272 cubic feet per acre per year, occurring at age 50. Yields are reduced by the Rock outcrop, which makes up about 40 percent of this unit. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, the Rock outcrop, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Ogarty soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

165—Ohop sandy loam, 0 to 8 percent slopes. This very deep, moderately well drained soil is on river terraces and valley toe slopes. It formed in Osceola mudflow. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,200 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and moss 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark grayish brown sandy loam. The upper 9 inches of the subsoil is dark brown very gravelly loam. The lower 12 inches is brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is brown extremely gravelly sandy loam. In some areas the surface layer is gravelly sandy loam. In other areas the substratum has more than 15 percent clay or has 15 to 35 percent rock fragments.

Included in this unit are small areas of Lemolo and Snoqualmie soils, organic soils, and Ohop soils that have slopes of more than 8 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is slow in the Ohop soil. Available water capacity is moderate. The effective rooting depth is limited by a perched high water table, which is at a depth of 2 to 3 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Douglas fir, western redcedar, red alder, and black cottonwood. The common forest understory plants

are Oregongrape, salal, western swordfern, vine maple, and red huckleberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is 148. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 246 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are occasional snowpack and the muddiness caused by seasonal wetness. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. When the surface layer is removed by harvesting activities, seedlings planted in the less fertile underlying material grow poorly and lack vigor. Reforestation can be accomplished by planting western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

166—Ohop very gravelly loam, 0 to 15 percent slopes. This very deep, moderately well drained soil is on river terraces and mountain toe slopes. It formed in recent volcanic mudflow. The native vegetation is mainly conifers and shrubs. Elevation is 1,400 to 2,400 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark grayish brown very gravelly loam 7 inches thick. The upper 9 inches of the subsoil is dark brown very gravelly loam. The lower 12 inches is brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is brown extremely gravelly sandy loam. In some areas the surface layer is gravelly loam or very gravelly sandy loam. In other areas the soil has a subsoil or substratum of loamy sand, is 40 to 60 inches deep to compacted mudflow, or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Grotto, Lemolo, and Pierking soils and Ohop soils that have slopes of more than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Ohop soil. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 2 to 3 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent is red alder. The common forest understory plants are vine maple, western swordfern, red huckleberry, trailing blackberry, salal, longtube twinflower, and foamflower.

On the basis of a 100-year site curve, the mean site index is 160 for Douglas fir and 148 for western hemlock. On the basis of a 50-year site curve, it is 127 for Douglas fir and 108 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 170 cubic feet per acre per year, occurring at age 65. For western hemlock it is 234 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are occasional snowpack and the seasonal high water table. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is

dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in production can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

167—Olomount gravelly loam, 8 to 30 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to fractured bedrock. It formed in a mixture of glacial till, volcanic ash, and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly loam 6 inches thick. The upper 8 inches of the subsoil is strong brown gravelly loam. The lower 19 inches is brownish yellow very gravelly loam. Andesite is at a depth of about 33 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Elwell, Oakes, and Philippa soils and Olomount soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Olomount soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, Pacific silver fir, and bigleaf maple. The common forest understory plants are western brackenfern, vine maple, deer fern, salmonberry, salal, trailing blackberry, red huckleberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index is 151 for Douglas fir and 161 for western hemlock. On the basis of a 50-year site curve, it is 122 for Douglas fir and 113 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 159 cubic feet per acre per year, occurring at age 60. For western hemlock it is 256 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

168—Olomount gravelly loam, 30 to 65 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to fractured bedrock. It formed in a mixture of glacial till, volcanic ash, and colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is

800 to 1,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly loam 6 inches thick. The upper 8 inches of the subsoil is strong brown gravelly loam. The lower 19 inches is brownish yellow very gravelly loam. Andesite is at a depth of about 33 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Elwell, Oakes, and Philippa soils and Olomount soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Olomount soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, Pacific silver fir, and bigleaf maple. The common forest understory plants are western brackenfern, vine maple, deer fern, salmonberry, salal, trailing blackberry, red huckleberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index is 151 for Douglas fir and 161 for western hemlock. On the basis of a 50-year site curve, it is 122 for Douglas fir and 113 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 159 cubic feet per acre per year, occurring at age 60. For western hemlock it is 256 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. During an average year, snowpack limits the use of equipment and restricts access from January through March. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

169—Olomount-Rock outcrop complex, 45 to 90 percent slopes. This map unit is on glacially modified back slopes and ridgetops. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 140 days.

This unit is 60 percent Olomount gravelly loam and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Elwell, Oakes, and Philippa soils, soils that are less than 20 inches deep over bedrock, stony areas, and Olomount soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Olomount soil is moderately deep to fractured bedrock and is well drained. It formed in a mixture of glacial till, volcanic ash, and colluvium derived dominantly from andesite. Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly loam 6 inches thick. The upper 8 inches of the subsoil is strong brown gravelly loam. The lower 19 inches is brownish yellow very gravelly loam. Andesite is at a depth of about 33 inches. The depth to andesite ranges

from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Olomount soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is andesite. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, Pacific silver fir, and bigleaf maple. The common forest understory plants are western brackenfern, vine maple, deer fern, salmonberry, salal, trailing blackberry, red huckleberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index is 151 for Douglas fir and 161 for western hemlock. On the basis of a 50-year site curve, it is 122 for Douglas fir and 113 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 159 cubic feet per acre per year, occurring at age 60. For western hemlock it is 256 cubic feet per acre per year, occurring at age 50. Yields are reduced by the Rock outcrop, which makes up about 30 percent of this unit. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, the Rock outcrop, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Olomount soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

170—Oridia silt loam, 0 to 2 percent slopes. This very deep, artificially drained soil is on flood plains. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is 30 to 120 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface layer is brown silt loam 11 inches thick. The upper 8 inches of the underlying material is brown, mottled silt loam. The lower part to a depth of 60 inches is grayish brown, brown, gray, and light brownish gray, mottled very fine sandy loam. In some areas the surface layer is very fine sandy loam. In other areas the soil has a dark brown surface layer, is sandy loam or loam in the lower part of the underlying material, has thin strata of sand, or has 18 to 25 percent clay in the upper part of the underlying material.

Included in this unit are small areas of undrained Oridia soils, Shalcar soils in depressions that are subject to ponding, and small bodies of water. Included

areas make up about 10 percent of the total acreage.

Permeability is moderate in the Oridia soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at a depth of 1 to 3 feet from November through April. Runoff generally is very slow but can be ponded during the winter months. There is no hazard of erosion. This soil is subject to occasional, brief periods of flooding from November through April.

Most areas of this soil are drained and used as hayland, pasture, or cropland. The included undrained Oridia soils are used as woodland and as a site for homes.

In the areas used for hay and pasture, the main limitations are the high water table and the hazard of flooding. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In undrained areas and in areas where the drainage system is not maintained, the water table limits the choice of forage species to grasses and shallow-rooted legumes. The wetness in these areas limits the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland are the high water table and the hazard of flooding. This soil is well suited to most of the crops commonly grown in the survey area if adequate drainage systems are maintained. The principal crops are corn silage and small grain. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth. During the growing season, the water table is artificially lowered by tile drains and field ditches to a depth of about 3 to 5 feet. Measures that maintain the drainage system are needed to ensure adequate production. Maintaining the drainage system permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar and black cottonwood. The common forest understory plants are salal, western brackenfern, western swordfern, spirea, rose, vine maple, and sedges.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

In the areas used for homesite development, the main limitations are the high water table and the flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings in areas where a suitable outlet is available. The seasonal high water table increases the likelihood that septic tank absorption fields will fail. Installing absorption lines that are longer than normal helps to overcome this limitation.

This unit is in capability subclass IIw.

171—Orthents, avalanche chutes-Humods complex, 30 to 100 percent slopes. This map unit is on back slopes in the mountains. The native vegetation is mainly shrubs. Elevation is 1,500 to 5,000 feet. The average annual precipitation is 80 to 120 inches, and the average annual air temperature is 38 to 48 degrees F. The average frost-free period is 90 to 140 days. The mean annual soil temperature ranges from 40 to 50 degrees F.

This unit is 70 percent Orthents and 20 percent Humods. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Reggad soils, organic soils in depressions, and Orthents and Humods that have slopes of less than 30 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Orthents are moderately deep to very deep and are well drained. They formed in colluvium derived from granite. No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface layer is very dark yellowish brown very cobbly sandy loam when mixed to a depth of 6 inches. The subsoil is dark yellowish brown very cobbly loamy sand 18 inches thick. The substratum is dark yellowish brown extremely stony loamy sand 6 inches thick. Granite is at a depth of about 30 inches. The depth to granite ranges from 20 to 80 inches.

Permeability is moderately rapid or rapid in the Orthents. Available water capacity is low. The effective rooting depth is 20 to more than 60 inches. Runoff is very rapid, and the hazard of water erosion is very severe.

The Humods are moderately deep to very deep and are well drained. They formed in colluvium derived from granite. No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface layer is black very gravelly sandy loam 5 inches thick. The upper 9 inches of the subsoil is reddish brown and dark brown extremely stony sandy loam. The lower 12 inches is dark yellowish brown extremely stony loam. Granite is at a depth of 26 inches. The depth to granite ranges from 20 to 80 inches.

Permeability is moderately rapid in the Humods. Available water capacity is low. The effective rooting depth is 20 to 80 inches. Runoff is very rapid, and the hazard of water erosion is very severe.

This unit is used as watershed.

This unit is in capability subclass VIIs.

172—Ovall gravelly loam, 15 to 30 percent slopes. This well drained soil is on back slopes in the foothills. It is moderately deep to fractured bedrock. It formed in glacial drift mixed with colluvium and residuum derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,500 feet. The average annual precipitation is about 50 inches, and the average annual air temperature is about 51 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of needles, moss, and twigs 1 inch thick. The surface layer is dark brown gravelly loam 3 inches thick. The subsoil is brown very gravelly loam 12 inches thick. The substratum is brown very gravelly sandy loam 9 inches thick. Andesite is at a depth of about 24 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Alderwood, Blethen, Ogarty, and Wilkeson soils and Ovall soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Ovall soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western hemlock. The common forest understory plants are salal, Oregongrape, vine maple, red huckleberry, western swordfern, western brackenfern, Pacific dogwood, and creambush oceanspray.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 132. On the basis of a 50-year site curve, it is 100. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 133 cubic feet per acre per year, occurring at age 70.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. The use of wheeled and tracked equipment during short periods when the soil is wet, however, causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by red

alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

173—Ovall gravelly loam, 30 to 65 percent slopes. This well drained soil is on back slopes in the foothills. It is moderately deep to fractured bedrock. It formed in glacial drift mixed with colluvium and residuum derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,500 feet. The average annual precipitation is about 50 inches, and the average annual air temperature is about 51 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of needles, moss, and twigs 1 inch thick. The surface layer is dark brown gravelly loam 3 inches thick. The subsoil is brown very gravelly loam 12 inches thick. The substratum is brown very gravelly sandy loam 9 inches thick. Andesite is at a depth of about 24 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Alderwood, Blethen, Ogarty, and Wilkeson soils and Ovall soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Ovall soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western hemlock. The common forest understory plants are salal, Oregongrape, vine maple, red huckleberry, western swordfern, western brackenfern, Pacific dogwood, and creambush oceanspray.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 132. On the basis of a 50-year site curve, it is 100. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 133 cubic feet per acre per year, occurring at age 70.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

174—Pastik silt loam, 0 to 30 percent slopes. This very deep, moderately well drained soil is on terraces and escarpments. It formed in lake sediments and volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown silt loam 6 inches thick. The subsurface layer also is dark brown silt loam 6 inches thick. The subsoil is 19 inches of dark yellowish brown and yellowish brown very fine sandy loam and silt loam. The substratum to a depth of 60 inches is olive brown

and grayish brown silt loam. In some areas the surface layer is sandy loam or loam. In other areas the substratum is silty clay.

Included in this unit are small areas of Nargar, Ogarty, Ragnar, Sulsavar, and Tokul soils and Pastik soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Pastik soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 1.5 to 2.5 feet from December through May. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used as pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used as woodland. In areas where slopes are less than 15 percent, it also is suitable for pasture and hayland.

Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, bigleaf maple, and red alder. The common forest understory plants are western swordfern, western brackenfern, ladyfern, red huckleberry, deer fern, and vine maple.

On the basis of a 100-year site curve, the mean site index is 177 for Douglas fir and 176 for western hemlock. On the basis of a 50-year site curve, it is 132 for Douglas fir and 123 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 188 cubic feet per acre per year, occurring at age 60. For western hemlock it is 285 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IIIe.

175—Persis sandy loam, 0 to 8 percent slopes. This very deep, well drained soil is on stream terraces. It formed in a mixture of volcanic ash and alluvium over deltaic deposits. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,600 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3.5 inches thick. When mixed to a depth of 4 inches, the surface layer is dark reddish brown sandy loam. The upper 9 inches of the subsoil is dark reddish brown loam. The lower 16 inches is dark brown and strong brown loam. The substratum to a depth of 60 inches is grayish brown sand. In some areas the surface layer is loam or loamy sand. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and 25 to 35 percent rock fragments in the substratum.

Included in this unit are small areas of Klaus, Rober, and Sauk soils and Persis soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Persis soil and rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are bunchberry dogwood, red huckleberry, salal, and western swordfern.

On the basis of a 100-year site curve, the mean site index for western hemlock is 162. On the basis of a 50-year site curve, it is 130. The highest average growth

rate in unmanaged, even-aged stands of western hemlock is 258 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Douglas fir have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Extra rock is needed to maintain a stable and uniform road surface. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist, a high degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

176—Persis sandy loam, windswept, 0 to 8 percent slopes. This very deep, well drained soil is on stream terraces. It formed in a mixture of volcanic ash and alluvium over deltaic deposits. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,600 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3.5 inches thick. When mixed to a depth of 4 inches, the surface layer is dark reddish brown sandy loam. The upper 9 inches of the subsoil is dark reddish brown loam. The lower 16 inches is dark brown and strong brown loam. The substratum to a depth of 60 inches is grayish brown sand. In some areas the surface layer is loam or loamy sand. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and 25 to 35 percent rock fragments in the substratum.

Included in this unit are small areas of Klaus, Rober, and Sauk soils and Persis soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Persis soil and rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are bunchberry dogwood, red huckleberry, salal, and western swordfern.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 138. On the basis of a 50-year site curve, it is estimated to be 100. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 214 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Douglas fir have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Extra rock is needed to maintain a stable and uniform road surface. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist, a high degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants

can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

177—Pheeney gravelly loam, 8 to 30 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to fractured bedrock. It formed in volcanic ash and in colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,500 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is very dark brown gravelly loam 11 inches thick. The upper 10 inches of the subsoil is dark brown very gravelly loam. The lower 13 inches is dark yellowish brown extremely gravelly loam. Fractured andesite is at a depth of about 34 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Littlejohn, Pitcher, and Zynbar soils and Pheeney soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pheeney soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are western brackenfern, vine maple, violet, Oregongrape, salal, western swordfern, red huckleberry, and Oregon oxalis.

On the basis of a 100-year site curve, the mean site index is 135 for Douglas fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas fir and 85 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 138 cubic feet per acre per year, occurring at age 70. For western hemlock it is 182 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

178—Pheeney gravelly loam, 30 to 65 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to fractured bedrock. It formed in volcanic ash and in colluvium derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,500 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is very dark brown gravelly loam 11 inches thick. The upper 10 inches of the subsoil is dark brown very gravelly loam. The lower 13 inches is dark yellowish brown extremely gravelly loam. Fractured andesite is at a depth of about 34 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other

areas the soil has 15 to 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Littlejohn, Pitcher, and Zynbar soils and Pheeney soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pheeney soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are western brackenfern, vine maple, violet, Oregongrape, salal, western swordfern, red huckleberry, and Oregon oxalis.

On the basis of a 100-year site curve, the mean site index is 135 for Douglas fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas fir and 85 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 138 cubic feet per acre per year, occurring at age 70. For western hemlock it is 182 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. During an average year, snowpack limits the use of equipment and restricts access from January through March. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

179—Pheeney gravelly silt loam, tuff substratum, 8 to 30 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to fractured bedrock. It formed in volcanic ash and in colluvium derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 1,500 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4.5 inches thick. The upper 4 inches of the surface layer is dark brown gravelly silt loam. The lower 8 inches is dark brown gravelly loam. The subsoil is dark yellowish brown extremely gravelly loam 22 inches thick. Weathered tuff is at a depth of about 34 inches. The depth to breccia or tuff ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Littlejohn, Pitcher, and Zynbar soils and Pheeney soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pheeney soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are western brackenfern, vine maple, violet, Oregongrape, salal, western swordfern, red huckleberry, and Oregon oxalis.

On the basis of a 100-year site curve, the mean site index is 135 for Douglas fir and 121 for western

hemlock. On the basis of a 50-year site curve, it is 101 for Douglas fir and 85 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 138 cubic feet per acre per year, occurring at age 70. For western hemlock it is 182 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

180—Pheeney gravelly silt loam, tuff substratum, 30 to 65 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to fractured bedrock. It formed in volcanic ash and in colluvium derived dominantly from breccia. The native vegetation is mainly conifers and shrubs. Elevation is 1,500 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4.5 inches thick. The upper 4 inches of the surface layer is dark brown gravelly silt loam. The lower 8 inches is dark brown gravelly loam. The subsoil is dark yellowish brown extremely gravelly loam 22 inches thick. Weathered tuff is at a depth of about 34 inches. The depth to breccia or tuff ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Pitcher, Littlejohn, and Zynbar soils and Pheeney soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pheeney soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are western brackenfern, vine maple, violet, Oregongrape, salal, western swordfern, red huckleberry, and Oregon oxalis.

On the basis of a 100-year site curve, the mean site index is 135 for Douglas fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas fir and 85 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 138 cubic feet per acre per year, occurring at age 70. For western hemlock it is 182 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. During an average year, snowpack limits the use of equipment and restricts access from January through March. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill

slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

181—Pheeney-Rock outcrop complex, 30 to 90 percent slopes. This map unit is on glacially modified back slopes and ridgetops. The native vegetation is mainly conifers and shrubs. Elevation is 1,500 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 170 days.

This unit is 50 percent Pheeney gravelly loam and 40 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Littlejohn, Pitcher, and Zynbar soils, soils that are less than 20 inches deep over bedrock, stony areas, and Pheeney soils that have slopes of less than 30 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Pheeney soil is moderately deep to fractured bedrock and is well drained. It formed in volcanic ash and in colluvium derived dominantly from andesite. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is very dark brown gravelly loam 11 inches thick. The upper 10 inches of the subsoil is dark brown very gravelly loam. The lower 13 inches is dark yellowish brown extremely gravelly loam. Fractured andesite is at a depth of about 34 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Pheeney soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is andesite. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are western brackenfern, vine maple, violet, Oregongrape, salal, western swordfern, red huckleberry, and Oregon oxalis.

On the basis of a 100-year site curve, the mean site index is 135 for Douglas fir and 121 for western hemlock. On the basis of a 50-year site curve, it is 101 for Douglas fir and 85 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 138 cubic feet per acre per year, occurring at age 70. For western hemlock it is 182 cubic feet per acre per year, occurring at age 50. Yields are reduced by the Rock outcrop, which makes up about 40 percent of this unit. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, occasional snowpack, the Rock outcrop, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Pheeney soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

182—Philippa sandy loam, 0 to 30 percent slopes. This moderately well drained soil is in cirques and on lateral moraines in the mountains. It is moderately deep to ortstein. It formed in a mixture of volcanic ash, colluvium, and ablation till over dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles and twigs 2 inches thick. When mixed to a depth of 4 inches, the surface layer is dark brown sandy loam. The upper 14 inches of the subsoil is variegated dark reddish brown, strong brown, and dark brown gravelly silt loam. The lower 10 inches is dark yellowish brown very gravelly sandy loam. Dark grayish brown ortstein that crushes to extremely gravelly loamy sand is at a depth of about 28 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till, or has a less developed subsoil.

Included in this unit are small areas of Kaleetan, Marblemount, Melakwa, and Teneriffe soils, soils that are less than 20 inches deep to ortstein, and Philippa soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Philippa soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common forest understory plants are western swordfern, deer fern, red huckleberry, salmonberry, vine maple, devilsclub, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 144. On the basis of a 50-year site curve, it is estimated to be 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 150 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is

wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

183—Philippa sandy loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is in cirques and on lateral moraines in the mountains. It formed in a mixture of volcanic ash, colluvium, and ablation till over dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles and twigs 2 inches thick. When mixed to a depth of 4 inches, the surface layer is dark brown sandy loam. The upper 5 inches of the subsoil is variegated dark reddish brown and strong brown gravelly silt loam. The next 9 inches is dark brown gravelly silt loam. The lower 10 inches is dark yellowish brown very gravelly sandy loam. Dark grayish brown ortstein that crushes to extremely gravelly loamy sand is at a depth of about 28 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till, or has a less developed subsoil.

Included in this unit are small areas of Kaleetan, Marblemount, Melakwa, and Teneriffe soils, soils that are less than 20 inches deep to ortstein, and Philippa soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Philippa soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from December through March. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common forest understory plants are western swordfern, deer fern, red huckleberry, salmonberry, vine maple, devilsclub, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 144. On the basis of a 50-year site curve, it is estimated to be 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 150 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural

reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

184—Pierking gravelly sandy loam, 0 to 3 percent slopes. This very deep, somewhat poorly drained soil is on river terraces. It formed in stream alluvium and mudflow deposits. The native vegetation is mainly conifers, hardwoods, and shrubs. Elevation is 1,200 to 2,000 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of leaves and needles 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly sandy loam. The subsoil is dark brown and very dark gray very gravelly sandy loam 28 inches thick. The substratum to a depth of 60 inches is dark bluish gray very gravelly sandy loam. In some areas the surface layer is loam, sandy loam, gravelly loam, or gravelly loamy sand. In other areas the substratum has sandy and loamy strata.

Included in this unit are small areas of Greenwater, Lemolo, Pilchuck, and Snoqualmie soils and Riverwash. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Pierking soil. Available water capacity is low. The effective rooting depth is limited by an apparent high water table, which is at a depth of 0.5 to 1.0 foot from November through March. Runoff is very slow, and there is no hazard of erosion. This soil is subject to rare flooding.

This unit is used as woodland. Western hemlock and red alder are the main woodland species. Among the trees of limited extent are western redcedar, Douglas fir, black cottonwood, grand fir, and Sitka spruce. The common forest understory plants are western swordfern, vine maple, Oregongrape, red huckleberry, devilsclub, skunk cabbage, ladyfern, montia, trailing blackberry, Oregon oxalis, salmonberry, horsetail, and elk sedge.

On the basis of a 100-year site curve, the mean site index is 139 for western hemlock. On the basis of a 50-year site curve, it is 102 for western hemlock and is estimated to be 100 for red alder. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 216 cubic feet per acre per year, occurring at age 60. For red alder it is about 118 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are occasional snowpack and the muddiness caused by seasonal wetness. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. When the surface layer is removed by harvesting activities, seedlings planted in the less fertile underlying material grow poorly and lack vigor. Reforestation can be accomplished by planting western hemlock, western redcedar, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, red alder, and western redcedar occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVw.

185—Pierking-Borohemists complex, 0 to 5 percent slopes. This map unit is on river terraces. The native vegetation is mainly conifers and shrubs. Elevation is 1,400 to 2,000 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 120 days.

This unit is 70 percent Pierking gravelly sandy loam, 0 to 5 percent slopes, and 20 percent Borohemists, 0 to

1 percent slopes. The Borohemists are in depressions on the terraces. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Greenwater, Lemolo, Pilchuck, and Snoqualmie soils. Included areas make up about 10 percent of the total acreage.

The Pierking soil is very deep and somewhat poorly drained. It formed in stream alluvium and mudflow deposits. Typically, the surface is covered with a mat of leaves and needles 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly sandy loam. The subsoil is dark brown and very dark gray very gravelly sandy loam 28 inches thick. The substratum to a depth of 60 inches is dark bluish gray very gravelly sandy loam. In some areas the surface layer is loam, sandy loam, gravelly loam, or gravelly loamy sand. In other areas the substratum has sandy and loamy strata.

Permeability is moderately slow in the Pierking soil. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 0.5 to 1.0 foot from November through March. Runoff is very slow and there is no hazard of erosion. This soil is subject to rare flooding.

The Borohemists are very deep and very poorly drained. They formed in partially decomposed herbaceous plant material over decomposed woody material having varying amounts of mineral material derived from alluvium or mudflow deposits. No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface layer is very dark brown mucky peat about 4 inches thick. The upper 26 inches of the underlying material is very dark grayish brown hemic material. The next 4 inches is very dark brown sandy loam. The lower part to a depth of 60 inches is dark reddish brown hemic material. The depth to mineral soil material ranges from 20 to more than 60 inches. After rubbing, the overall content of fiber ranges from 20 to 30 percent, although individual layers can have as much as 50 percent. Reaction is extremely acid or very strongly acid.

Permeability is moderate in the Borohemists. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from October through June. Runoff is ponded, and there is no hazard of erosion. These soils are subject to rare flooding.

The Pierking soil is used as woodland. The Borohemists are used for wildlife habitat. They are poorly suited to timber production.

Western hemlock and red alder are the main woodland species on the Pierking soil. Among the trees of limited extent are western redcedar, Douglas fir, black cottonwood, grand fir, and Sitka spruce. The common forest understory plants are western swordfern, vine maple, Oregongrape, red huckleberry, devilsclub, skunk cabbage, ladyfern, montia, trailing blackberry, Oregon oxalis, salmonberry, horsetail, and elk sedge. The native vegetation on the Borohemists consists mainly of hardhack, cattail, rushes, and sedges. It also includes some Sitka spruce, western redcedar, western hemlock, and red alder. Ponding on these soils may result in the mortality of coniferous trees.

On the basis of a 100-year site curve, the mean site index on the Pierking soil is 139 for western hemlock. On the basis of a 50-year site curve, it is 102 for western hemlock and is estimated to be 100 for red alder. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 216 cubic feet per acre per year, occurring at age 60. For red alder it is about 118 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are occasional snowpack, the muddiness caused by seasonal wetness, and ponding in scattered areas of the Borohemists. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soils are moist, a moderate degree of puddling when the soils are wet, and a moderate degree of soil displacement when the soils are dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production on the Pierking soil. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. When the surface layer is removed by harvesting activities, seedlings planted in the less fertile underlying material grow poorly and lack vigor. Reforestation can be accomplished by planting western hemlock, western redcedar, or red alder seedlings. If seed trees are

available, natural reforestation of cutover areas by western hemlock, red alder, and western redcedar occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soils are wet and winds are strong.

The Pierking soil is in capability subclass IVw. The Borohemists are in capability subclass Vw.

186—Pierking-Mowich complex, 2 to 15 percent slopes. This map unit is on back slopes in river valleys. The native vegetation is mainly conifers and shrubs. Elevation is 1,400 to 2,000 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 120 days.

This unit is 60 percent Pierking gravelly sandy loam, 2 to 5 percent slopes, and 30 percent Mowich silt loam, 2 to 15 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Lemolo and Norma soils, Borohemists, and Mowich soils that have slopes of more than 15 percent. Included areas make up about 10 percent of the total acreage.

The Pierking soil is very deep and somewhat poorly drained. It formed in stream alluvium and mudflow deposits. Typically, the surface is covered with a mat of leaves and needles 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly sandy loam. The subsoil is dark brown and very dark gray very gravelly sandy loam 28 inches thick. The substratum to a depth of 60 inches is dark bluish gray very gravelly sandy loam. In some areas the surface layer is loam, sandy loam, gravelly loam, or gravelly loamy sand. In other areas the substratum has sandy and loamy strata.

Permeability is moderately slow in the Pierking soil. Available water capacity is low. The effective rooting depth is limited by an apparent high water table, which is at a depth of 0.5 to 1.0 foot from November through March. Runoff is very slow, and there is no hazard of erosion.

The Mowich soil is very deep and somewhat poorly drained. It formed in volcanic ash over glaciolacustrine sediments. Typically, the surface is covered with a mat of organic material 8 inches thick. The surface layer is dark brown silt loam 7 inches thick. The upper 3 inches of the subsoil is strong brown silt loam. The lower 16 inches is dark yellowish brown, mottled silt loam. The substratum to a depth of 60 inches is light brownish gray, mottled silty clay. Depth to the clayey substratum ranges from 20 to 35 inches. In some areas the surface layer is loam. In other areas the substratum has 30 to 45 percent clay or is at a depth of 10 to 20 inches.

Permeability is slow in the Mowich soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 2 feet from November through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock, Douglas fir, and red alder are the main woodland species. Among the trees of limited extent are western redcedar, black cottonwood, grand fir, and Sitka spruce. The common forest understory plants are western swordfern, salal, vine maple, Oregongrape, red huckleberry, devilsclub, deer fern, skunk cabbage, ladyfern, montia, trailing blackberry, Oregon oxalis, salmonberry, horsetail, and elk sedge.

On the basis of a 100-year site curve, the mean site index on the Pierking soil is 139 for western hemlock. On the basis of a 50-year site curve, it is 102 for western hemlock and is estimated to be 100 for red alder. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 216 cubic feet per acre per year, occurring at age 60. For red alder it is about 118 cubic feet per acre per year, occurring at age 40.

On the basis of a 100-year site curve, the mean site index on the Mowich soil is 156 for Douglas fir. On the basis of a 50-year site curve, it is 121. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 165 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are occasional snowpack and the muddiness caused by seasonal wetness. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate to high degree of soil compaction when the soils are moist, a moderate to high degree of puddling when the soils are wet, and a moderate degree of soil displacement when the soils are dry. Carefully laying out roads and skid trails, properly timing their use, and

using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. When the surface layer is removed by harvesting activities, seedlings planted in the less fertile underlying material grow poorly and lack vigor. Reforestation can be accomplished by planting western hemlock, western redcedar, or red alder on the Pierking soil and Douglas fir on the Mowich soil. If seed trees are available, natural reforestation of cutover areas by western hemlock, red alder, and western redcedar occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

This unit is in capability subclass IVw.

187—Pilchuck loamy fine sand, 0 to 3 percent slopes. This very deep, somewhat excessively drained soil is on flood plains. It formed in sandy alluvium. The native vegetation is mainly trees and shrubs. Elevation is 200 to 800 feet. The average annual precipitation is about 50 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 0.5 inch thick. The surface layer is very dark grayish brown loamy fine sand 9 inches thick. The upper 46 inches of the underlying material is very dark grayish brown and very dark gray loamy fine sand and fine sand. The lower part to a depth of 60 inches is black very gravelly sand. In some areas the surface layer is loamy sand, sand, or sandy loam. In other areas the soil is stratified with fine sandy loam or is 30 to 40 inches deep to very gravelly sand.

Included in this unit are small areas of Edgewick and Snoqualmie soils, organic or poorly drained mineral soils in depressions, Riverwash, and soils that are similar to the Pilchuck soil but have a seasonal high water at a depth of 48 to 60 inches. Included areas make up about 10 percent of the total acreage.

Permeability is rapid in the Pilchuck soil. Available water capacity is moderate. The effective rooting depth is limited by an apparent high water table, which is at a depth of 2 to 4 feet from November through April. Runoff is very slow, and the hazard of water erosion is severe because of the susceptibility to flooding and channeling. This soil is subject to occasional, brief periods of flooding from November through April. The flooding occurs during periods of snowmelt and rainfall.

This unit is used mainly as woodland. It also is used as pasture and grazable woodland. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. Because of inherently low fertility, this soil requires more fertilizer than most other soils in the survey area if it is to produce similar yields. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, bigleaf maple, and black cottonwood. The common forest understory plants are vine maple, western swordfern, salmonberry, common snowberry, false Solomons seal, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 152. On the basis of a 50-year site curve, it is estimated to be 114. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 161 cubic feet per acre per year, occurring at age 60.

The main hazard affecting timber harvesting is the flooding. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. The seedling survival rate may be low where flooding occurs. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder, bigleaf maple, and black cottonwood occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing

vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVw.

188—Pitcher sandy loam, 8 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash over colluvium and residuum derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1.5 inches thick. The surface layer is dark brown sandy loam 8 inches thick. The upper 8 inches of the subsoil is dark brown gravelly sandy loam. The next 13 inches is brown very gravelly loam. The lower part to a depth of 60 inches is brown and yellowish brown very gravelly loam. In some areas the surface layer is loam, gravelly loam, or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Kaleetan, Littlejohn, and Olomount soils and Pitcher soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pitcher soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir, Pacific silver fir, and red alder. The common forest understory plants are western swordfern, vine maple, red huckleberry, salal, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 145. On the basis of a 50-year site curve, it is estimated to be 112. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 152 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

189—Pitcher sandy loam, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash over colluvium and residuum derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1.5 inches thick. The surface layer is dark brown sandy loam 8 inches thick. The upper 8 inches of the subsoil is dark brown gravelly sandy loam. The next 13 inches is brown very gravelly loam. The lower part to a depth of 60 inches is brown and yellowish brown very gravelly loam. In some areas the surface layer is loam, gravelly loam, or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Kaleetan, Littlejohn, and Olomount soils and Pitcher soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pitcher soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir, Pacific silver fir, and red alder. The common forest understory plants are western swordfern, vine maple, red huckleberry, salal, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 145. On the basis of a 50-year site curve, it is 112. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 152 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

190—Pitcher sandy loam, windswept, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash over colluvium and residuum derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1.5 inches thick. The surface layer is dark brown sandy loam 8 inches thick. The upper 8 inches of the subsoil is dark brown gravelly sandy loam. The next 13 inches is brown very gravelly loam. The lower part to a depth of 60 inches is brown and yellowish brown very gravelly loam. In some areas the surface layer is loam, gravelly loam, or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Kaleetan, Littlejohn, and Olomount soils and Pitcher soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pitcher soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir, Pacific silver fir, and red alder. The common forest understory plants are western swordfern, vine maple, red huckleberry, salal, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 133. On the basis of a 50-year site curve, it is estimated to be 100. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 134 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of western hemlock have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally

are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

191—Pitcher sandy loam, tuff substratum, 8 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash over colluvium and residuum derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer is dark brown sandy loam 7 inches thick. The upper 6 inches of the subsoil is dark yellowish brown gravelly sandy loam. The lower 16 inches is dark brown very gravelly sandy loam and dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is brown extremely gravelly sandy loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is loam, gravelly loam, or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Kaleetan, Littlejohn, and Olomount soils and Pitcher soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pitcher soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir, Pacific silver fir, and red alder. The common forest understory plants are western swordfern, vine maple, red huckleberry, salal, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 145. On the basis of a 50-year site curve, it is estimated to be 112. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 152 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover

areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

192—Pitcher sandy loam, tuff substratum, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash over colluvium and residuum derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer is dark brown sandy loam 7 inches thick. The upper 6 inches of the subsoil is dark yellowish brown gravelly sandy loam. The lower 16 inches is brown very gravelly sandy loam and dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is brown extremely gravelly sandy loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is loam, gravelly loam, or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Kaleetan, Littlejohn, and Olomount soils and Pitcher soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pitcher soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir, Pacific silver fir, and red alder. The common forest understory plants are western swordfern, vine maple, red huckleberry, salal, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 145. On the basis of a 50-year site curve, it is 112. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 151 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

193—Pitcher sandy loam, tuff substratum, windswept, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash over colluvium and residuum derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface

layer is dark brown sandy loam 7 inches thick. The upper 6 inches of the subsoil is dark yellowish brown gravelly sandy loam. The lower 16 inches is brown very gravelly sandy loam and dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is brown extremely gravelly sandy loam. In some areas the surface layer is loam, gravelly loam, or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Kaleetan, Littlejohn, and Olomount soils and Pitcher soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Pitcher soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir, Pacific silver fir, and red alder. The common forest understory plants are western swordfern, vine maple, red huckleberry, salal, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 133. On the basis of a 50-year site curve, it is estimated to be 100. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 134 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of western hemlock have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

194—Pitcher-Rock outcrop complex, 30 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

This unit is 60 percent Pitcher sandy loam and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Kaleetan, Littlejohn, and Olomount soils, stony areas, and Pitcher soils that have slopes of less than 30 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Pitcher soil is very deep and well drained. It formed in volcanic ash over colluvium and residuum derived dominantly from extrusive igneous rocks. Typically, the surface is covered with a mat of needles, leaves, and twigs 1.5 inches thick. The surface layer is dark brown sandy loam 8 inches thick. The upper 8 inches of the subsoil is dark brown gravelly sandy loam. The next 13 inches is brown very gravelly loam. The lower part to a depth of 60 inches is brown and yellowish brown very gravelly loam. In some areas the surface layer is loam, gravelly loam, or gravelly sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Pitcher soil. Available

water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

Typically, the Rock outcrop is extrusive igneous rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are noble fir, Pacific silver fir, and red alder. The common forest understory plants are western swordfern, vine maple, red huckleberry, salal, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 145. On the basis of a 50-year site curve, it is 112. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 151 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. Yields are reduced by the Rock outcrop, which makes up about 30 percent of this unit.

The main limitations affecting timber harvesting are the slope, the Rock outcrop, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs occasionally. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The Pitcher soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

195—Pits. This map unit is on outwash terraces and mountain foothills. It consists of areas excavated for gravel, sand, and hard rock. Areas are irregular in shape and are 5 to 90 acres in size.

Included in this unit are small areas of soils that have not been excavated, partially filled dump sites, and small ponds in areas where material has been excavated below the water table. Included areas make up about 10 percent of the total acreage.

A seasonal high water table fluctuates between the surface and a depth of more than 60 inches from November through April. Permeability, the effective rooting depth, available water capacity, surface runoff, and the hazard of erosion vary, depending on the amount of surface disturbance. Runoff is ponded to very rapid. In some areas there is no hazard of water erosion. In other areas the hazard is slight to severe.

This unit is used mainly as a source of gravel, sand, and rock. It also is used for wildlife habitat. It varies widely in texture and depth to bedrock. Onsite evaluation is needed to determine suitable uses. Reclamation is needed for most potential uses.

This unit is in capability subclass VIIIs.

196—Playco loamy sand, 8 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice mixed with colluvium derived from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 3,600 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of

needles, twigs, bark, and moss 1 inch thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown loamy sand. The upper 4 inches of the subsoil is dark brown sandy loam. The lower 26 inches is dark brown very gravelly loam and dark yellowish brown extremely gravelly loam. The substratum to a depth of 60 inches is yellowish brown very gravelly loam. In some areas the surface layer is sandy loam or gravelly sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Nagrom and Nimue soils and Playco soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Playco soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Douglas fir. The common forest understory plants are montia, trillium, devilsclub, huckleberry, Oregongrape, Pacific yew, salal, and western swordfern.

On the basis of a 100-year site curve, the mean site index for western hemlock is 127. On the basis of a 50-year site curve, it is 89. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 194 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIe.

197—Playco loamy sand, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice mixed with colluvium derived from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 3,600 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 1 inch thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown loamy sand. The upper 4 inches of the subsoil is dark brown sandy loam. The lower 26 inches is dark brown very gravelly loam and dark yellowish brown extremely gravelly loam. The substratum to a depth of 60 inches is yellowish brown very gravelly loam. In some areas the surface layer is sandy loam or gravelly sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Nagrom and Nimue soils and Playco soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Playco soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Douglas fir. The common forest understory plants are montia, trillium, devilsclub, huckleberry, Oregongrape, Pacific yew, salal, and western swordfern.

On the basis of a 100-year site curve, the mean site index for western hemlock is 127. On the basis of a 50-year site curve, it is 89. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 194 cubic feet per acre per year, occurring

at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIIe.

198—Playco loamy sand, 65 to 90 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice mixed with colluvium derived from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 3,600 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 1 inch thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown loamy sand. The upper 4 inches of the subsoil is dark brown sandy loam. The lower 26 inches is dark brown very gravelly loam and dark yellowish brown extremely gravelly loam. The substratum to a depth of 60 inches is yellowish brown very gravelly loam. In some areas the surface layer is sandy loam or gravelly sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Included in this unit are small areas of Nagrom and Nimue soils and Playco soils that have slopes of less than 65 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Playco soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Douglas fir. The common forest understory plants are montia, trillium, devilsclub, huckleberry, Oregongrape, Pacific yew, salal, and western swordfern.

On the basis of a 100-year site curve, the mean site index for western hemlock is 127. On the basis of a 50-year site curve, it is 89. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 194 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling

and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIIe.

199—Playco very gravelly loamy sand, tuff substratum, 8 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice mixed with colluvium derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 3,600 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown very gravelly loamy sand. The upper 10 inches of the subsoil is dark yellowish brown very gravelly loamy sand. The lower 33 inches is dark yellowish brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is olive brown extremely gravelly sandy loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is gravelly sandy loam, gravelly loamy sand, or very gravelly sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Nagrom and Nimue soils and Playco soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Playco soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Douglas fir. The common forest understory plants are montia, trillium, devilsclub, huckleberry, Oregongrape, Pacific yew, salal, and western swordfern.

On the basis of a 100-year site curve, the mean site index for western hemlock is 113. On the basis of a 50-year site curve, it is 79. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 166 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIe.

200—Playco very gravelly loamy sand, tuff substratum, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice mixed with colluvium

derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 3,600 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown very gravelly loamy sand. The upper 10 inches of the subsoil is dark yellowish brown very gravelly loamy sand. The lower 33 inches is dark yellowish brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is olive brown extremely gravelly sandy loam. The depth to tuff or breccia commonly ranges from 5 to 10 feet. In some areas the surface layer is gravelly sandy loam, gravelly loamy sand, or very gravelly sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Nagrom and Nimue soils and Playco soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Playco soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Douglas fir. The common forest understory plants are montia, trillium, devilsclub, huckleberry, Oregongrape, Pacific yew, salal, and western swordfern.

On the basis of a 100-year site curve, the mean site index for western hemlock is 113. On the basis of a 50-year site curve, it is 79. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 166 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIIe.

201—Playco-Rock outcrop complex, 30 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 3,600 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

This unit is 60 percent Playco loamy sand and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Nagrom, Nimue, and Reggad soils, talus, soils that are 10 to 20 inches deep over bedrock, and Playco soils that have slopes of less than 30 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Playco soil is very deep and well drained. It formed in volcanic ash and pumice mixed with colluvium derived dominantly from extrusive igneous rocks. Typically, the surface is covered with a mat of needles, twigs, and bark 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown loamy sand. The upper 4 inches of the subsoil is dark

reddish brown sandy loam. The lower 26 inches is dark brown very gravelly loam and dark yellowish brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is yellowish brown very gravelly loam. In some areas the surface layer is gravelly sandy loam, gravelly loamy sand, or very gravelly sandy loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Playco soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is extrusive igneous rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and Douglas fir. The common forest understory plants are montia, trillium, devilsclub, huckleberry, Oregongrape, Pacific yew, salal, and western swordfern.

On the basis of a 100-year site curve, the mean site index for western hemlock is 127. On the basis of a 50-year site curve, it is 89. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 194 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 30 percent of this unit.

The main limitations affecting timber harvesting are snowpack, the Rock outcrop, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November though April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation.

The Playco soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

202—Puget silty clay loam, 0 to 2 percent slopes. This very deep, artificially drained soil is on flood plains. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is 25 to 500 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

When mixed to a depth of 7 inches, the surface layer is dark grayish brown silty clay loam. The upper 33 inches of the underlying material is grayish brown, mottled silty clay loam. The next 5 inches is greenish gray, mottled silty clay loam. The lower part to a depth of 60 inches is gray, mottled silty clay. In some areas the surface layer is silt loam. In other areas the soil has a dark brown surface layer. In places the underlying material is sandy loam or loamy sand, has 10 to 18 percent clay, or has thin strata of sandy or organic material.

Included in this unit are small areas of undrained Puget soils, Shalcar soils in depressions that are subject to ponding, and small bodies of water. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Puget soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at a depth of 1 to 3 feet from November through May.

Runoff generally is very slow, but it can be ponded during the winter months. There is no hazard of erosion. This soil is subject to occasional, brief periods of flooding from November through April.

This unit is used mainly as cropland, hayland, or pasture. The included undrained Puget soils are used as woodland.

In the areas used for hay and pasture, the main limitations are the high water table, the hazard of flooding, and the moderately slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In undrained areas and in areas where the drainage system is not maintained, the water table limits the choice of forage species to grasses and shallow-rooted legumes. The wetness in these areas limits the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland are the high water table, the hazard of flooding, and the moderately slow permeability. This soil is well suited to most of the crops commonly grown in the survey area if adequate drainage systems are maintained. The principal crops are corn silage and small grain. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth. During the growing season, the water table is artificially lowered by tile drains and field ditches to a depth of about 3 to 5 feet. Measures that maintain the drainage system are needed to ensure adequate production. Maintaining the drainage system permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are black cottonwood and western redcedar. The common forest understory plants are salal, western brackenfern, western swordfern, spirea, rose, vine maple, and sedges.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong. The seedling survival rate may be low where flooding occurs.

In the areas used for homesite development, the main limitations are the high water table and the hazard of flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings in areas where a suitable outlet is available. The moderately slow permeability and the high water table increase the likelihood that septic tank absorption fields will fail. Installing absorption lines that are longer than normal helps to overcome these limitations.

This unit is in capability subclass IIw.

203—Ragnar loam, 6 to 15 percent slopes. This very deep, well drained soil is on terraces. It formed in glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,000 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 180 days.

Typically, the surface layer is covered with a mat of undecomposed needles, leaves, and twigs 1 inch thick. The surface layer is dark brown loam 13 inches thick. The subsoil is dark yellowish brown sandy loam 11 inches thick. The substratum to a depth of 60 inches is light olive brown loamy sand. Depth to the substratum ranges from 20 to 30 inches. In some areas the surface layer is sandy loam. In other areas the substratum has 15 to 40 percent pebbles. In places the combined

thickness of the surface layer and subsoil is 8 to 20 inches.

Included in this unit are small areas of Barneston and Lynnwood soils, Norma soils in depressions, and Ragnar soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Ragnar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used for hay and pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used as hayland, pasture, or woodland. In the areas used for hay and pasture, the main limitation is the slope. In summer, irrigation is required for maximum production.

Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder and western redcedar. The common forest understory plants are western swordfern, western brackenfern, Oregongrape, salal, huckleberry, trailing blackberry, and evergreen huckleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 168. On the basis of a 50-year site curve, it is 126. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 179 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist, a high degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

204—Ragnar loam, 15 to 30 percent slopes. This very deep, well drained soil is on terraces. It formed in glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,000 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 180 days.

Typically, the surface layer is covered with a mat of undecomposed needles, leaves, and twigs 1 inch thick. The surface layer is dark brown loam 13 inches thick. The subsoil is dark yellowish brown sandy loam 11 inches thick. The substratum to a depth of 60 inches is light olive brown loamy sand. Depth to the substratum ranges from 20 to 30 inches. In some areas the surface layer is sandy loam. In other areas the substratum has 15 to 40 percent pebbles. In places the combined thickness of the surface layer and subsoil is 8 to 20 inches.

Included in this unit are small areas of Barneston and Lynnwood soils, Norma soils in depressions, and Ragnar soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the Ragnar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder and western redcedar. The common forest understory plants are western swordfern, western brackenfern, Oregongrape, salal, huckleberry, trailing blackberry, and evergreen huckleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 168. On the basis of a 50-year site curve, it is 126. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 179 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet

causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist, a high degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

205—Ragnar-Lynnwood complex, 2 to 15 percent slopes. This map unit is on outwash terraces. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 600 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 180 days.

This unit is 45 percent Ragnar loam and 45 percent Lynnwood loamy fine sand. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Barneston soils, Norma soils in depressions, and Ragnar and Lynnwood soils that have slopes of more than 15 percent or less than 2 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Ragnar soil is very deep and well drained. It formed in glacial outwash. Typically, the surface layer is covered with a mat of undecomposed needles, leaves, and twigs 1 inch thick. The surface layer is dark brown loam 13 inches thick. The subsoil is dark yellowish brown sandy loam 11 inches thick. The substratum to a depth of 60 inches is light olive brown loamy sand. Depth to the substratum ranges from 20 to 30 inches. In some areas the surface layer is sandy loam. In other areas the substratum has 15 to 40 percent pebbles. In places the combined thickness of the surface layer and subsoil is 8 to 20 inches.

Permeability is moderately rapid in the Ragnar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used for hay and pasture, however, runoff is medium and the hazard of erosion is moderate.

The Lynnwood soil is very deep and somewhat excessively drained. It formed in glacial outwash. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown loamy fine sand. The upper 15 inches of the subsoil is dark yellowish brown loamy fine sand. The lower 5 inches is olive brown fine sand. The substratum to a depth of 60 inches is olive fine sand. In some areas the surface layer is sandy loam or loam. In other areas the soil has 15 to 25 percent pebbles in the substratum or is 14 to 24 inches deep to loamy sand or sand.

Permeability is rapid in the Lynnwood soil. Available water capacity is moderate. The effective rooting depth is 60 inches or more. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used as pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used as woodland, hayland, or pasture. In the areas used for hay and pasture, the main limitations are the slope of both soils and the moderate available water capacity of the Lynnwood soil. In summer, irrigation is required for maximum production.

Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder and western redcedar. The common forest understory plants are western swordfern, western brackenfern, Oregongrape, salal, red huckleberry, ladyfern, deer fern, and evergreen huckleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 168 on the Ragnar soil and 154 on the Lynnwood soil. On the basis of a 50-year site curve, it is 126 on the Ragnar soil and 121 on the Lynnwood soil. On the Ragnar soil the highest average growth rate in unmanaged, even-aged stands of Douglas fir is 179 cubic feet per acre per year, occurring at age 60. On the Lynnwood soil it is 163 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of

wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soils are moist, a moderate degree of soil displacement when the soils are dry, and a moderate degree of puddling when the soils are wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The Ragnar soil is in capability subclass IIIe. The Lynnwood soil is in capability subclass IVs.

206—Ragnar-Lynnwood complex, 30 to 45 percent slopes. This map unit is on terraces. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 600 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 180 days.

This unit is 45 percent Ragnar loam and 45 percent Lynnwood loamy fine sand. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Barneston soils and Lynnwood and Ragnar soils that have slopes of more than 45 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Ragnar soil is very deep and well drained. It formed in glacial outwash. Typically, the surface layer is covered with a mat of undecomposed needles, leaves, and twigs 1 inch thick. The surface layer is dark brown loam 13 inches thick. The subsoil is dark yellowish brown sandy loam 11 inches thick. The substratum to a depth of 60 inches is light olive brown loamy sand. Depth to the substratum ranges from 20 to 30 inches. In some areas the surface layer is sandy loam. In other areas the substratum has 15 to 40 percent pebbles. In places the combined thickness of the surface layer and subsoil is 8 to 20 inches.

Permeability is moderately rapid in the Ragnar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

The Lynnwood soil is very deep and somewhat excessively drained. It formed in glacial outwash. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown loamy fine sand. The upper 15 inches of the subsoil is dark yellowish brown loamy fine sand. The lower 5 inches is olive brown fine sand. The substratum to a depth of 60 inches is olive fine sand. In some areas the surface layer is sandy loam or loam. In other areas the soil has 15 to 25 percent pebbles in the substratum or is 14 to 24 inches deep to loamy sand or sand.

Permeability is rapid in the Lynnwood soil. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder and western redcedar. The common forest understory plants are western swordfern, western brackenfern, Oregongrape, salal, red huckleberry, ladyfern, deer fern, and evergreen huckleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 168 on the Ragnar soil and 154 on the Lynnwood soil. On the basis of a 50-year site curve, it is 126 on the Ragnar soil and 121 on the Lynnwood soil. On the Ragnar soil the highest average growth rate in unmanaged, even-aged stands of Douglas fir is 179 cubic feet per acre per year, occurring at age 60. On the Lynnwood soil it is 163 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soils are moist, a moderate degree of puddling when the soils are wet, and a moderate degree of soil displacement

when the soils are dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment and mortality are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The Ragnar soil is in capability subclass VIe. The Lynnwood soil is in capability subclass VIs.

207—Reggad very cobbly muck, 30 to 90 percent slopes. This very deep, excessively drained soil is on mountain back slopes. It formed in a mixture of organic material, volcanic ash, and pumice over rock rubble. The native vegetation is mainly shrubs. Elevation is 2,800 to 6,000 feet. The average annual precipitation is about 95 inches, and the average annual air temperature is about 41 degrees F. The average frost-free period is about 100 days.

When mixed to a depth of 8 inches, the upper part of the surface layer is very dark brown very cobbly muck. The lower part is very dark grayish brown very cobbly sapric material 9 inches thick. The underlying material to a depth of 60 inches is dark yellowish brown angular rock fragments. In some areas the lower part of the surface layer is very cobbly sandy loam or very cobbly loamy sand. In other areas the soil is 10 to 14 inches deep to the angular rock fragments.

Included in this unit are small areas of Klapatche, Playco, Reichel, and Treen soils, Rock outcrop, Rubble land, and Reggad soils that have slopes of more than 90 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is very rapid in the Reggad soil. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for wildlife habitat. The native vegetation is vine maple, Sitka alder, tall blue huckleberry, western swordfern, and devilsclub. Rock for road construction is readily available. Road construction is difficult because of the loose, angular rock fragments. The instability of this material when undercut results in rock movement and costly road maintenance.

This unit is in capability subclass VIIIs.

208—Reggad-Haywire complex, 45 to 90 percent slopes. This map unit is on mountain back slopes and ridgetops. The native vegetation is mainly shrubs and some conifers. Elevation is 3,400 to 6,000 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 41 degrees F. The average frost-free period is about 100 days.

This unit is 70 percent Reggad very cobbly muck and 20 percent Haywire sandy loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Klapatche, Playco, Serene, and Treen soils and Reggad and Haywire soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage.

The Reggad soil is very deep and excessively drained. It formed in a mixture of organic material, volcanic ash, and pumice over rock rubble. When mixed to a depth of 8 inches, the upper part of the surface layer is very dark brown very cobbly muck. The lower part is very dark grayish brown very cobbly sapric material 9 inches thick. The underlying material to a depth of 60 inches is dark yellowish brown angular rock fragments. In some areas the lower part of the surface layer is very cobbly sandy loam or very cobbly loamy sand. In other areas the soil is 10 to 14 inches deep to the angular rock fragments.

Permeability is very rapid in the Reggad soil. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

The Haywire soil is moderately deep to bedrock and is well drained. It formed in volcanic ash and pumice over colluvium and residuum derived from extrusive igneous rocks. Typically, the surface is covered with a mat of needles and twigs 1 inch thick. When mixed to a depth of 4 inches, the surface layer is dusky red sandy loam. The upper 5 inches of the subsoil is dark reddish brown loam. The next 8 inches is dark reddish brown gravelly loam. The lower 8 inches is dark brown very cobbly loam. The substratum is dark yellowish brown extremely cobbly loam 11 inches thick. Andesite is at a

depth of about 36 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, loam, or gravelly loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Permeability is moderate in the Haywire soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used mainly for wildlife habitat. The Haywire soil also is used as woodland. The Reggad soil is poorly suited to woodland.

Western hemlock and Pacific silver fir are the main woodland species on the Haywire soil. Among the trees of limited extent is noble fir. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, deer fern, princes pine, salal, dwarf huckleberry, pachystima, and Oregongrape. The native vegetation on the Reggad soil is vine maple, Sitka alder, tall blue huckleberry, western swordfern, and devilsclub.

On the basis of a 100-year site curve, the mean site index for western hemlock on the Haywire soil is 87. On the basis of a 50-year site curve, it is 59. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 100 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the very cobbly Reggad soil, which makes up about 70 percent of this unit.

The main limitations affecting timber harvesting are the cobbles in the Reggad soil, snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Road construction on the Reggad soil is difficult because of the loose, angular rock fragments. The instability of this material when undercut results in rock movement and costly road maintenance. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soils are moist and a moderate degree of puddling when the soils are wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings on the Haywire soil. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock underlying the Haywire soil, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Reggad soil is in capability subclass VIIIs. The Haywire soil is in capability subclass VIIe.

209—Reggad-Klapatche-Rock outcrop complex, 45 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly shrubs and some conifers. Elevation is 2,800 to 4,000 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 110 days.

This unit is 45 percent Reggad very cobbly loam, 20 percent Klapatche loamy sand, and 15 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Playco and Treen soils, talus, and Reggad and Klapatche soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Reggad soil is very deep and excessively drained. It formed in a mixture of organic material, volcanic ash, and pumice over rock rubble. When mixed

to a depth of 8 inches, the upper part of the surface layer is very dark brown very cobbly muck. The lower part is very dark grayish brown very cobbly sapric material 9 inches thick. The underlying material to a depth of 60 inches is dark yellowish brown angular rock fragments. In some areas the lower part of the surface layer is very cobbly sandy loam or very cobbly loamy sand. In other areas the soil is 10 to 14 inches deep to the angular rock fragments.

Permeability is very rapid in the Reggad soil. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

The Klapatche soil is moderately deep to bedrock and is well drained. It formed in a mixture of volcanic ash and pumice over colluvium derived dominantly from granitic and metamorphic rocks. Typically, the surface is covered with a mat of needles, twigs, bark, and moss 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark reddish brown loamy sand. The upper 4 inches of the subsoil is yellowish red and dark reddish brown very gravelly sandy loam. The lower 8 inches is strong brown very gravelly loamy sand. The upper 11 inches of the substratum is very pale brown extremely cobbly sand. The lower 7 inches is light gray, highly weathered granodiorite. Hard granodiorite is at a depth of about 38 inches. The depth to hard granitic or metamorphic rocks ranges from 30 to 40 inches. In some areas the surface layer is sandy loam, gravelly loamy sand, or very gravelly loamy sand. In other areas the soil has a substratum of very gravelly sandy loam, has 15 to 35 percent rock fragments in the subsoil, or is 40 to 60 inches deep over bedrock.

Permeability is moderately rapid in the Klapatche soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium or rapid, and the hazard of water erosion is moderate or severe.

Typically, the Rock outcrop is granitic or metamorphic rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used mainly for wildlife habitat. The Klapatche soil also is used as woodland. The Reggad soil is poorly suited to woodland.

Western hemlock and Pacific silver fir are the main woodland species on the Klapatche soil. Among the trees of limited extent are noble fir, Douglas fir, and Alaska cedar. The common forest understory plants are huckleberry, common beargrass, salal, longtube twinflower, bunchberry dogwood, Oregongrape, princes pine, and Sitka alder. The native vegetation on the Reggad soil is vine maple, Sitka alder, tall blue huckleberry, western swordfern, and devilsclub.

On the basis of a 100-year site curve, the mean site index for western hemlock on the Klapatche soil is estimated to be 101. On the basis of a 50-year site curve, it is estimated to be 72. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 144 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop and the very cobbly Reggad soil, which make up about 60 percent of this unit.

The main limitations affecting timber harvesting are the cobbles in the Reggad soil, snowpack, the Rock outcrop, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Road construction on the Reggad soil is difficult because of the loose, angular rock fragments. The instability of this material when undercut results in rock movement and costly road maintenance. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soils are dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soils. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and

naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings on the Klapatche soil. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the bedrock underlying the Klapatche soil, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Reggad soil and the Rock outcrop are in capability subclass VIIIs. The Klapatche soil is in capability subclass VIIs.

210—Reggad-Serene complex, 45 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly shrubs and some conifers. Elevation is 3,600 to 6,000 feet. The average annual precipitation is about 95 inches, and the average annual air temperature is about 41 degrees F. The average frost-free period is about 100 days.

This unit is 70 percent Reggad very cobbly loam and 20 percent Serene gravelly sandy loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Haywire and Treen soils and Reggad and Serene soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage.

The Reggad soil is very deep and excessively drained. It formed in a mixture of organic material, volcanic ash, and pumice over rock rubble. When mixed to a depth of 8 inches, the upper part of the surface layer is very cobbly muck. The lower part is very dark brown very cobbly sapric material 9 inches thick. The underlying material to a depth of 60 inches is dark yellowish brown angular rock fragments. In some areas the lower part of the surface layer is very cobbly sandy loam or very cobbly loamy sand. In other areas the soil is 10 to 14 inches deep to the angular rock fragments.

Permeability is very rapid in the Reggad soil. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

The Serene soil is moderately deep to weathered bedrock and is well drained. It formed in a mixture of volcanic ash, pumice, and colluvium derived from granitic and low-grade metamorphic rocks. Typically, the surface is covered with a mat of needles, twigs, and bark 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown gravelly sandy loam. The subsoil is dark yellowish brown very gravelly loamy sand 8 inches thick. The substratum is olive brown extremely cobbly coarse sand 16 inches thick. Highly weathered granodiorite is at a depth of about 30 inches. The depth to granodiorite ranges from 20 to 40 inches. In some areas the surface layer is sandy loam, loamy sand, or gravelly loamy sand. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Permeability is rapid in the Serene soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used mainly for wildlife habitat. The Serene soil also is used as woodland. The Reggad soil is poorly suited to woodland.

Western hemlock and Pacific silver fir are the main woodland species on the Serene soil. Among the trees of limited extent are noble fir and mountain hemlock. The common forest understory plants on the Serene soil are common beargrass, longtube twinflower, bunchberry dogwood, huckleberry, deer fern, princes pine, lupine, salal, cascade azalea, and trailing blackberry. The native vegetation on the Reggad soil is vine maple, Sitka alder, tall blue huckleberry, western swordfern, and devilsclub.

On the basis of a 100-year site curve, the mean site index for western hemlock on the Serene soil is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the very cobbly Reggad soil, which makes up about 70 percent of this unit.

The main limitations affecting timber harvesting are the cobbles in the Reggad soil, snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Road construction on the Reggad soil is difficult because of

the loose, angular rock fragments. The instability of this material when undercut results in rock movement and costly road maintenance. Cut and fill slopes tend to ravel when dry. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soils are dry. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings on the Serene soil. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock underlying the Serene soil, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Reggad soil is in capability subclass VIIIs. The Serene soil is in capability subclass VIIs.

211—Reichel silt loam, 6 to 30 percent slopes. This deep, well drained soil is on mountain ridgetops and back slopes. It formed in a mixture of volcanic ash and colluvium and residuum derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 4,000 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of undecomposed needles, leaves, and twigs 3 inches thick. The upper 10 inches of the surface layer is very dark brown silt loam. The lower part is very dark grayish brown silt loam 8 inches thick. The subsoil is dark yellowish brown gravelly loam 10 inches thick. The substratum is dark brown very gravelly clay loam 19 inches thick. Andesite is at a depth of about 47 inches. The depth to andesite ranges from 40 to 60 inches. In some areas the surface layer is loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil.

Included in this unit are small areas of Nagrom, Spukwush, and Stahl soils and Reichel soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Reichel soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, and Alaska cedar. The common forest understory plants are red huckleberry, Pacific trillium, Oregongrape, western brackenfern, princes pine, Oregon oxalis, false Solomons seal, and ladyfern.

On the basis of a 100-year site curve, the mean site index is 138 for western hemlock and 131 for Douglas fir. On the basis of a 50-year site curve, it is 98 for western hemlock and 100 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 214 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 132 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from December through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, noble fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIe.

212—Reichel silt loam, 30 to 65 percent slopes. This deep, well drained soil is on mountain ridgetops and back slopes. It formed in a mixture of volcanic ash and colluvium and residuum derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 4,000 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of undecomposed needles, leaves, and twigs 3 inches thick. The surface layer is very dark brown silt loam 10 inches thick. The upper 8 inches of the subsoil is very dark grayish brown silt loam. The lower 10 inches is dark yellowish brown gravelly clay loam. The substratum is dark brown very gravelly clay loam 19 inches thick. Andesite is at a depth of about 47 inches. The depth to andesite ranges from 40 to 60 inches. In some areas the surface layer is loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil.

Included in this unit are small areas of Nagrom, Spukwush, and Stahl soils and Reichel soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Reichel soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, and Alaska cedar. The common forest understory plants are red huckleberry, Pacific trillium, Oregongrape, western brackenfern, princes pine, Oregon oxalis, false Solomons seal, and ladyfern.

On the basis of a 100-year site curve, the mean site index is 138 for western hemlock and 131 for Douglas fir. On the basis of a 50-year site curve, it is 98 for western hemlock and 100 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 214 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 132 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from December through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, noble fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

213—Reichel silt loam, tuff substratum, 15 to 30 percent slopes. This very deep, well drained soil is on mountain ridgetops and back slopes. It formed in a

mixture of volcanic ash and colluvium and residuum derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 4,000 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of undecomposed needles, leaves, and twigs 3 inches thick. The surface layer is dark brown silt loam 14 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loam 31 inches thick. The substratum to a depth of 60 inches is very dark grayish brown very gravelly loam. The depth to breccia or tuff ranges from 40 to 80 inches. In some areas the surface layer is loam. In other areas the soil has less than 6 percent organic carbon in the subsoil.

Included in this unit are small areas of Nagrom, Spukwush, and Stahl soils and Reichel soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Reichel soil. Available water capacity is high. The effective rooting depth is 40 to more than 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, and Alaska cedar. The common forest understory plants are red huckleberry, Pacific trillium, Oregongrape, western brackenfern, princes pine, Oregon oxalis, false Solomons seal, and ladyfern.

On the basis of a 100-year site curve, the mean site index is 138 for western hemlock and 131 for Douglas fir. On the basis of a 50-year site curve, it is 98 for western hemlock and 100 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 214 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 132 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from December through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, noble fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIe.

214—Reichel silt loam, tuff substratum, 30 to 65 percent slopes. This very deep, well drained soil is on mountain ridgetops and back slopes. It formed in a mixture of volcanic ash and colluvium and residuum derived dominantly from breccia. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 4,000 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of undecomposed needles, leaves, and twigs 3 inches thick. The surface layer is dark brown silt loam 14 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loam 31 inches thick. The substratum to a depth of 60 inches is very dark grayish brown very gravelly loam. The depth to breccia or tuff ranges from 40 to more than 60 inches. In some areas the surface layer is loam. In other areas the soil has less than 6 percent organic carbon in the subsoil.

Included in this unit are small areas of Nagrom,

Spukwush, and Stahl soils and Reichel soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Reichel soil. Available water capacity is high. The effective rooting depth is 40 to more than 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, and Alaska cedar. The common forest understory plants are red huckleberry, Pacific trillium, Oregongrape, western brackenfern, princes pine, Oregon oxalis, false Solomons seal, and ladyfern.

On the basis of a 100-year site curve, the mean site index is 138 for western hemlock and 131 for Douglas fir. On the basis of a 50-year site curve, it is 98 for western hemlock and 100 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 214 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 132 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from December through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting western hemlock, noble fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

215—Riverwash. This map unit is on bottom land along rivers. It is frequently flooded. Slope is 0 to 2 percent. Areas are irregular in shape and are 5 to 100 acres in size. The native vegetation is mainly small trees, scattered shrubs, and grass. Most areas, however, are unvegetated. Elevation is 40 to 900 feet. The average annual precipitation is 50 to 90 inches, and the average annual air temperature is 46 to 49 degrees F. The average frost-free period is 150 to 190 days.

No single profile is representative of this unit. In one of the more commonly observed ones, however, stratified cobbles, pebbles, and sand extend to a depth of 60 inches.

Included in this unit are small areas of Pilchuck and Snoqualmie soils on flood plains, Xerorthents on low terraces, and bodies of water. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid or very rapid in the Riverwash. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is severe because of the susceptibility to flooding and channeling. Channeling and deposition are common along streambanks. This unit is subject to frequent, long or very long periods of flooding from October through July. The seasonal high water table is within a depth of 2 feet throughout the year.

This unit is used mainly for wildlife habitat and recreational development. It also is a source of sand and gravel; however, riverside habitat is destroyed by obtaining these materials. The main limitations affecting woodland, pasture, or cropland are the frequent flooding and a lack of soil fertility.

This unit is in capability subclass VIIIw.

216—Rober loam, 0 to 30 percent slopes. This very deep, moderately well drained soil is on mountain back slopes and plateaus. It formed in volcanic ash and glaciolacustrine sediments. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown loam. The subsoil is dark brown and dark yellowish brown loam 24 inches thick. The substratum to a depth of 60 inches is grayish brown, mottled silt loam. In some areas, the surface layer is silt loam and the substratum is stratified with silty clay loam.

Included in this unit are small areas of Klaus, Pastik, Philippa, and Teneriffe soils, poorly drained mineral soils in depressions, and Rober soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Rober soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 2.0 to 3.5 feet from December through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are western swordfern, brackenfern, ladyfern, red huckleberry, Oregongrape, red elderberry, and vine maple.

On the basis of a 100-year site curve, the mean site index is 154 for Douglas fir and 153 for western hemlock. On the basis of a 50-year site curve, it is 121 for Douglas fir and 108 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 163 cubic feet per acre per year, occurring at age 60. For western hemlock it is 243 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

217—Rober loam, 30 to 65 percent slopes. This very deep, moderately well drained soil is on mountain back slopes. It formed in volcanic ash and glaciolacustrine sediments. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,800 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown loam. The subsoil is dark brown and dark yellowish brown loam 24 inches thick. The substratum to a depth of 60 inches is grayish brown, mottled silt loam. In some areas the surface layer is silt loam.

Included in this unit are small areas of Klaus, Pastik, Philippa, and Teneriffe soils, poorly drained mineral soils in depressions, and Rober soils that have slopes of less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Rober soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 2.0 to 3.5 feet from December through May. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are

western swordfern, brackenfern, ladyfern, red huckleberry, Oregongrape, red elderberry, and vine maple.

On the basis of a 100-year site curve, the mean site index is 154 for Douglas fir and 153 for western hemlock. On the basis of a 50-year site curve, it is 121 for Douglas fir and 108 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 163 cubic feet per acre per year, occurring at age 60. For western hemlock it is 243 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

218—Rock outcrop. This map unit is on mountainsides and ridges. Slope is 70 to more than 100 percent. Areas are irregular in shape and are 5 to 400 acres in size. Elevation is 1,000 to 5,200 feet.

Typically, the Rock outcrop is granite, andesite, breccia, or metasedimentary rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

Included in this unit are soils in areas too small to be mapped at the selected scale and small areas of Rubble land. Included areas make up about 10 percent of the total acreage.

Runoff is rapid on the Rock outcrop, and the hazard of water erosion is severe. This unit is used for rock quarries and wildlife habitat.

This unit is in capability subclass VIIIs.

219—Rock outcrop-Cattcreek complex, 65 to 90 percent slopes. This map unit is on mountain back slopes and in cirque basins. The native vegetation is mainly conifers and shrubs. Elevation generally is 2,800 to 4,000 feet. Some areas, however, extend to 5,300 feet. The average annual precipitation is about 105 inches, and the average annual air temperature is about 39 degrees F. The average frost-free period is about 110 days.

This unit is 50 percent Rock outcrop and 40 percent Cattcreek very cindery loamy sand. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Cotteral soils, soils that are less than 20 inches deep and vary in content of rock fragments, organic soils in depressions, and Cattcreek soils that have slopes of less than 65 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

Typically, the Rock outcrop is andesite. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

The Cattcreek soil is very deep and well drained. It formed in dacitic pumice and volcanic ash over residuum and colluvium derived dominantly from andesite. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown very cindery loamy sand 7 inches thick. The upper 4 inches of the subsoil is strong brown very cindery loamy sand. The lower 10 inches is strong brown very cindery sand. The substratum to a depth of 60 inches is dark yellowish brown and olive brown very gravelly sandy loam. In some areas the surface layer is extremely cindery loamy sand or cindery loamy sand. In other areas the soil is 40 to 60 inches deep to andesite or sandstone, has 15 to 35 percent rock fragments in the substratum, or is 30 to 60 inches deep to dense glacial till.

Permeability is very rapid in the upper part of the

Cattcreek soil and moderate in the substratum. Available water capacity is moderate. The effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir, western redcedar, western white pine, and Alaska cedar. The common forest understory plants are common beargrass, longtube twinflower, western brackenfern, evergreen blackberry, black mountain huckleberry, princes pine, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 124 for western hemlock and is estimated to be 117 for Douglas fir. On the basis of a 50-year site curve, it is 86 for western hemlock and is estimated to be 90 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 188 cubic feet per acre per year, occurring at age 50. For Douglas fir it is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 50 percent of this unit.

The main limitations affecting timber harvesting are the slope, the Rock outcrop, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity.

Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting Douglas fir, noble fir, or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. Trees are occasionally subject to windthrow because the surface layer and subsoil are loose.

The Rock outcrop is in capability subclass VIIIs. The Cattcreek soil is in capability subclass VIIe.

220—Rock outcrop-Cayuse complex, 30 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 5,000 to 6,200 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 38 degrees F. The average frost-free period is about 95 days.

This unit is 50 percent Rock outcrop and 30 percent Cayuse sandy loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of soils with that have more than 35 percent rock fragments throughout, soils that are less than 20 inches deep and vary in content of rock fragments, organic soils in depressions, and Cayuse soils that have slopes of less than 30 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Typically, the Rock outcrop is andesite or basalt. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

The Cayuse soil is very deep and well drained. It formed in volcanic ash and pumice over residuum and colluvium derived dominantly from andesite or basalt. Typically, the surface is covered with a mat of needles, twigs, and moss 0.25 inch thick. The upper 4 inches of the surface layer is very dark grayish brown sandy

loam. The lower 9 inches is dark brown sandy loam. The upper 17 inches of the subsoil is brown loam. The lower 6 inches is dark yellowish brown gravelly loam. The substratum to a depth of 60 inches is variegated dark yellowish brown and yellowish brown very gravelly loam. In some areas the surface layer is loamy sand. In other areas the soil has 15 to 35 percent rock fragments in the lower part of the subsoil and in the substratum.

Permeability is moderate in the Cayuse soil. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are subalpine fir and Engelmann spruce. The common forest understory plants are fawnlily, wild ginger, roughfruit berry, tall blue huckleberry, oneleaf foamflower, bunchberry dogwood, and lambstongue fawnlily.

On the basis of a 100-year site curve, the mean site index for western hemlock is 77. On the basis of a 50-year site curve, it is 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 84 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 50 percent of this unit.

The main limitations affecting timber harvesting are the Rock outcrop, the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through June. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting noble fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation.

The Rock outcrop is in capability subclass VIIIs. The Cayuse soil is in capability subclass VIIe.

221—Rock outcrop-Haywire complex, 45 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 6,000 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

This unit is 50 percent Rock outcrop and 40 percent Haywire sandy loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Klapatche, Playco, and Serene soils, Rubble land, soils that are less than 20 inches deep and vary in content of rock fragments, organic soils in depressions, and Haywire soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

Typically, the Rock outcrop is andesite or basalt. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

The Haywire soil is moderately deep to bedrock and is well drained. It formed in volcanic ash and pumice over colluvium and material weathered from extrusive igneous rocks. Typically, the surface is covered with a mat of needles and twigs 1 inch thick. When mixed to a

depth of 4 inches, the surface layer is dusky red sandy loam. The upper 5 inches of the subsoil is dark reddish brown loam. The next 8 inches is dark reddish brown gravelly loam. The lower 8 inches is dark brown very cobbly loam. The substratum is dark yellowish brown extremely cobbly loam 11 inches thick. Andesite is at a depth of about 36 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, loam, or gravelly loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Permeability is moderate in the Haywire soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used mainly for wildlife habitat. The Haywire soil also is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, deer fern, princes pine, salal, dwarf huckleberry, pachystima, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is 87. On the basis of a 50-year site curve, it is 59. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 100 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 50 percent of this unit.

The main limitations affecting timber harvesting are the Rock outcrop, snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Rock outcrop is in capability subclass VIIIs. The Haywire soil is in capability subclass VIIe.

222—Rock outcrop-Rubble land-Haywire complex, 45 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 3,400 to 6,000 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

This unit is 35 percent Rock outcrop, 30 percent Rubble land, and 25 percent Haywire sandy loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Klapatche, Playco, and Serene soils, soils that are less than 20

inches deep and vary in content of rock fragments, organic soils in depressions, and Haywire soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

Typically, the Rock outcrop is andesite or basalt. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

The Rubble land is on talus slopes. It consists of angular stones and boulders.

The Haywire soil is moderately deep to bedrock and is well drained. It formed in volcanic ash and pumice over colluvium and material weathered from extrusive igneous rocks. Typically, the surface is covered with a mat of needles and twigs 1 inch thick. When mixed to a depth of 4 inches, the surface layer is dusky red sandy loam. The upper 5 inches of the subsoil is dark reddish brown loam. The next 8 inches is dark reddish brown gravelly loam. The lower 8 inches is dark brown very cobbly loam. The substratum is dark yellowish brown extremely cobbly loam 11 inches thick. Andesite is at a depth of about 36 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is loamy sand, loam, or gravelly loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Permeability is moderate in the Haywire soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used mainly for wildlife habitat. It also is used as a source of aggregate. The Haywire soil is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is noble fir. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, black mountain huckleberry, deer fern, princes pine, salal, dwarf huckleberry, pachystima, and Oregongrape. The native vegetation on the Rubble land is sparse. It consists mainly of huckleberry, ferns, and forbs.

On the basis of a 100-year site curve, the mean site index for western hemlock is 87. On the basis of a 50-year site curve, it is 59. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 100 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop and the Rubble land, which make up about 65 percent of this unit.

The main limitations affecting timber harvesting are the Rock outcrop, the Rubble land, snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop and Rubble land on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop or the Rubble land. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available on this unit. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Because of the Rock outcrop and the Rubble land, yarding and skidding paths converge. This convergence results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. The Rock outcrop and

the Rubble land prevent the even distribution of reforestation. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Rock outcrop and the Rubble land are in capability subclass VIIIs. The Haywire soil is in capability subclass VIIe.

223—Rock outcrop-Rubble land-Serene complex, 45 to 90 percent slopes. This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 6,000 feet. The average annual precipitation is about 95 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

This unit is 35 percent Rock outcrop, 30 percent Rubble land, and 25 percent Serene gravelly sandy loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Haywire and Reggad soils, soils that are less than 20 inches deep and vary in content of rock fragments, organic soils in depressions, and Serene soils that have slopes of less than 45 percent. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

Typically, the Rock outcrop is granite and low-grade metamorphic rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

The Rubble land is on talus slopes. It consists of angular stones and boulders.

The Serene soil is moderately deep to weathered bedrock and is well drained. It formed in a mixture of volcanic ash, pumice, and colluvium derived from granitic and low-grade metamorphic rocks. Typically, the surface is covered with a mat of needles, twigs, and bark 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 8 inches of the subsoil is dark yellowish brown very gravelly loamy sand. The lower 16 inches is olive brown extremely cobbly coarse sand. Highly weathered granodiorite is at a depth of about 30 inches. The depth to granodiorite ranges from 20 to 40 inches. In some areas the surface layer is sandy loam, loamy sand, or gravelly loamy sand. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Permeability is moderately rapid in the Serene soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used mainly as wildlife habitat. It also is used as a source of aggregate. The Serene soil is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and mountain hemlock. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, huckleberry, deer fern, princes pine, lupine, salal, cascade azalea, and trailing blackberry. The native vegetation on the Rubble land is sparse. It consists mainly of huckleberry, ferns, and forbs.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop and the Rubble land, which make up about 65 percent of this unit.

The main limitations affecting timber harvesting are the Rock outcrop, the Rubble land, snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop and the Rubble land on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop or the Rubble land. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Because of the Rock outcrop and the Rubble land, yarding and skidding paths converge. This convergence results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying

out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop and the Rubble land prevent the even distribution of reforestation. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Rock outcrop and the Rubble land are in capability subclass VIIIs. The Serene soil is in capability subclass VIIs.

224—Rubble land. This map unit is on talus slopes at the base of rock outcrops. It consists of angular stones and boulders. Slope is 30 to 100 percent. The native vegetation is sparse. It is mainly huckleberry, ferns, and forbs. Elevation is 2,000 to 4,000 feet. The average annual precipitation is 70 to 100 inches, and the average annual air temperature is 40 to 43 degrees F. The average frost-free period is 80 to 100 days.

Typically, this unit is loosely piled, angular stones and boulders to a depth of 60 inches.

Included in this unit are small areas of Rock outcrop and areas where the rubble is less than 60 inches deep. Included areas make up about 10 percent of the total acreage.

This unit is used for wildlife habitat and as a source of aggregate.

This unit is in capability subclass VIIIs.

225—Rugles silt loam, 0 to 15 percent slopes. This very deep, well drained soil is on dissected terraces. It formed in a mixture of lacustrine deposits and tephra. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,400 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of partially decomposed needles and twigs 2 inches thick. When mixed to a depth of 11 inches, the surface layer is dark brown silt loam. The upper 34 inches of the subsoil is dark brown and grayish brown silt loam. The lower 12 inches is grayish brown silt loam. The substratum to a depth of 60 inches is grayish brown silty clay loam. In some areas the surface layer is loam. In other areas the soil has a seasonal high water table at a depth of 40 to 60 inches from December through April.

Included in this unit are small areas of Jonas, Rober, and Zynbar soils, poorly drained mineral soils in depressions, and Rugles soils that have slopes of more than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Rugles soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, black cottonwood, Sitka spruce, and western redcedar. The common forest understory plants are western swordfern, deer fern, bedstraw, red huckleberry, trillium, western brackenfern, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 170. On the basis of a 50-year site curve, it is 129. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 181 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are

available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

226—Salal silt loam, 0 to 2 percent slopes. This very deep, moderately well drained soil is on river terraces and flood plains. It formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 500 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 150 days.

Typically, the upper 11 inches of the surface layer is black silt loam. The lower 39 inches is very dark grayish brown silt loam. The underlying material to a depth of 60 inches is dark grayish brown silt loam. In some areas the surface layer is very fine sandy loam. In other areas the soil has a substratum that is stratified with fine sandy loam and sand, has sand at a depth of 40 to 60 inches, or has more than 50 percent base saturation in the surface layer.

Included in this unit are small areas of Edgewick and Si soils and Salal soils that have slopes of more than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Salal soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at a depth of 3 or 4 feet from February through April. Runoff is very slow, and there is no hazard of erosion. This soil is subject to occasional, brief periods of flooding from November through March.

This unit is used mainly as hayland, pasture, or cropland. It also is used as woodland and as a site for homes.

In the areas used for hay and pasture, the main limitation is the seasonal high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and help to control runoff and erosion.

The main limitation in the areas used as cropland is the seasonal high water table. This unit is suited to all of the crops commonly grown in the survey area. The principal crops are oats and corn silage. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, and red alder. The common forest understory plants are trailing blackberry, salmonberry, western swordfern, red elderberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 151. On the basis of a 50-year site curve, it is estimated to be 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 159 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and the hazard of flooding. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

In the areas used for homesite development, the main limitations are the flooding and the seasonal high water table. The seasonal high water table increases the likelihood that septic tank absorption fields will fail. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

This unit is in capability subclass IIIw.

227—Sauk silt loam, 0 to 8 percent slopes. This very deep, well drained soil is on river terraces. It formed in alluvium containing volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 800 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 49 degrees F. The average frost-free period is about 155 days.

Typically, the surface layer is covered with a mat of needles, leaves, and twigs 1.5 inches thick. The surface

layer is very dark brown silt loam 6 inches thick. The upper 16 inches of the subsoil is dark brown silt loam and dark yellowish brown fine sandy loam. The lower 20 inches is olive brown and dark brown fine sandy loam. The substratum to a depth of 60 inches is olive brown very gravelly loamy sand. Depth to the substratum ranges from 40 to 60 inches. In some areas the surface layer is loam or fine sandy loam. In other areas the substratum has 15 to 35 percent rock fragments or is below a depth of 60 inches.

Included in this unit are small areas of Persis, Pilchuck, Shalcar, and Sultan soils and Sauk soils that are occasionally flooded for brief periods or that have slopes of more than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Sauk soil and rapid in the substratum. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly as woodland. It also is used for hay and pasture.

This unit is well suited to hay and pasture. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are bigleaf maple, red alder, western hemlock, and western redcedar. The common forest understory plants are Oregongrape, western brackenfern, western swordfern, salmonberry, vine maple, and red huckleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 173. On the basis of a 50-year site curve, it is estimated to be 130. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 184 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, red alder, or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIe.

228—Scamman silt loam, 6 to 15 percent slopes. This very deep, somewhat poorly drained soil is on terraces. It formed in glacial and sedimentary material. The native vegetation is mainly trees and shrubs. Elevation is 800 to 1,700 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 175 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer is dark yellowish brown silt loam 6 inches thick. The subsurface layer is light brownish gray silt loam 8 inches thick. The upper 13 inches of the subsoil is grayish brown, mottled silty clay. The lower part to a depth of 60 inches is dark grayish brown, mottled silty clay. In some areas the surface layer is silty clay loam. In other areas the soil has 20 to 35 percent clay or more than 60 percent clay in the subsoil. In places a substratum that has 15 to 35 percent rock fragments is below a depth of 40 inches.

Included in this unit are small areas of Mashel soils, ponded areas, and Scamman soils that have slopes of less than 6 percent or more than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is slow in the Scamman soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 0.5 foot to 1.5 feet from November through April. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used as pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used as woodland. It also is suitable as pasture and hayland.

Douglas fir and red alder are the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, bigleaf maple, bitter cherry, and Oregon ash. The common forest understory plants are western swordfern, Oregongrape, western

brackenfern, salal, red huckleberry, trailing blackberry, salmonberry, vine maple, rose, creambush oceanspray, red elderberry, Oregon oxalis, and cascara buckthorn.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 152. On the basis of a 50-year site curve, it is 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 161 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of red alder have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IIIe.

229—Scamman silt loam, 15 to 30 percent slopes. This very deep, somewhat poorly drained soil is on terraces and on back slopes in the foothills. It formed in glacial and sedimentary material. The native vegetation is mainly trees and shrubs. Elevation is 800 to 1,700 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 175 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer is dark yellowish brown silt loam 6 inches thick. The subsurface layer is light brownish gray silt loam 8 inches thick. The upper 13 inches of the subsoil is grayish brown, mottled silty clay. The lower part to a depth of 60 inches is dark grayish brown, mottled silty clay. In some areas the surface layer is silty clay loam. In other areas the soil has 20 to 35 percent clay or more than 60 percent clay in the subsoil. In places a substratum that has 15 to 35 percent rock fragments is below a depth of 40 inches.

Included in this unit are small areas of Mashel soils and Scamman soils that have slopes of less than 15 percent or more than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is slow in the Scamman soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 0.5 foot to 1.5 feet from November through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. Douglas fir and red alder are the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, bigleaf maple, bitter cherry, and Oregon ash. The common forest understory plants are western swordfern, Oregongrape, western brackenfern, salal, red huckleberry, trailing blackberry, salmonberry, vine maple, rose, creambush oceanspray, red elderberry, Oregon oxalis, and cascara buckthorn.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 152. On the basis of a 50-year site curve, it is 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 161 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of red alder have not been made.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a

high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

230—Scamman silt loam, 30 to 65 percent slopes. This very deep, somewhat poorly drained soil is on terraces and on back slopes in the foothills. It formed in glacial and sedimentary material. The native vegetation is mainly trees and shrubs. Elevation is 800 to 1,700 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 175 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer is dark yellowish brown silt loam 6 inches thick. The subsurface layer is light brownish gray silt loam 8 inches thick. The upper 13 inches of the subsoil is grayish brown, mottled silty clay. The lower part to a depth of 60 inches is dark grayish brown, mottled silty clay. In some areas the surface layer is silty clay loam. In other areas the soil has 20 to 35 percent clay or more than 60 percent clay in the subsoil. In places a substratum that has 15 to 35 percent rock fragments is below a depth of 40 inches.

Included in this unit are small areas of Mashel soils and Scamman soils that have slopes of less than 30 percent or more than 65 percent. Included areas make up about 10 percent of the total acreage.

Permeability is slow in the Scamman soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 0.5 foot to 1.5 feet from November through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. Douglas fir and red alder are the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, bigleaf maple, bitter cherry, and Oregon ash. The common forest understory plants are western swordfern, Oregongrape, western brackenfern, salal, red huckleberry, trailing blackberry, salmonberry, vine maple, rose, creambush oceanspray, red elderberry, Oregon oxalis, and cascara buckthorn.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 152. On the basis of a 50-year site curve, it is 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 161 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of red alder have not been made.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing

plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

231—Seattle muck, 0 to 1 percent slopes. This very deep, very poorly drained soil is in depressions in river valleys and on glacial till plains. It formed in herbaceous and woody organic deposits. The native vegetation is mainly shrubs, forbs, and trees. Elevation is 300 to 800 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface layer is dark brown muck 8 inches thick. The underlying material to a depth of 60 inches is dark brown and black, stratified sapric and hemic material. In some areas the soil is all hemic material or all sapric material.

Included in this unit are small areas of Puget and Shalcar soils, ponded areas, drained Seattle soils, and Seattle soils that have slopes of more than 1 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Seattle soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at or above the surface from October through May. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly as woodland or for wildlife habitat. It also is used as pasture where drained.

In the areas used for hay and pasture, the main limitation is the high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, black cottonwood, and Sitka spruce. The common forest understory plants are western swordfern, devilsclub, vine maple, sedges, and rushes.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 85. The highest average growth rate in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the seasonal high water table and low strength. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass Vw.

232—Serene gravelly sandy loam, 8 to 30 percent slopes. This well drained soil is on mountain ridge crests and back slopes. It is moderately deep to weathered bedrock. It formed in a mixture of volcanic ash, pumice, and colluvium derived dominantly from granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 6,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 8 inches of the subsoil is dark yellowish brown very gravelly loamy sand. The lower 16 inches is olive brown extremely cobbly coarse sand. Highly weathered granodiorite is at a depth of about 30 inches. The depth to bedrock ranges from 20 to 40 inches. In some areas the surface layer is sandy loam, loamy sand, or gravelly

loamy sand. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil, is 40 to 60 inches deep over bedrock, or is underlain by conglomerate.

Included in this unit are small areas of Haywire and Reggad soils, soils that are 10 to 20 inches deep over bedrock, Rock outcrop, and Serene soils that have slopes of less than 8 percent or more than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Serene soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and mountain hemlock. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, huckleberry, deer fern, princes pine, lupine, salal, cascade azalea, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIs.

233—Serene gravelly sandy loam, 30 to 65 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to weathered bedrock. It formed in a mixture of volcanic ash, pumice, and colluvium derived dominantly from granitic and metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 6,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, twigs, bark, and moss 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 8 inches of the subsoil is dark yellowish brown very gravelly loamy sand. The lower 16 inches is olive brown extremely cobbly coarse sand. Highly weathered granodiorite is at a depth of about 30 inches. The depth to bedrock ranges from 20 to 40 inches. In some areas the surface layer is sandy loam, loamy sand, or gravelly loamy sand. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil, is 40 to 60 inches deep over bedrock, or is underlain by conglomerate.

Included in this unit are small areas of Haywire and Reggad soils, soils that are 10 to 20 inches deep over bedrock, Rock outcrop, and Serene soils that have slopes of less than 30 percent or more than 65 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderately rapid in the Serene soil.

Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and mountain hemlock. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, huckleberry, deer fern, princes pine, lupine, salal, cascade azalea, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIs.

234—Serene-Rock outcrop complex, 45 to 90 percent slopes. This map unit is on mountain back slopes and shoulder slopes. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 5,000 feet. The average annual precipitation is about 95 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 100 days.

This unit is 50 percent Serene gravelly sandy loam and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Haywire and Reggad soils, Rubble land, soils that are less than 20 inches deep and vary in content of rock fragments, organic soils in depressions, and Serene soils that have slopes of less than 45 percent. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Serene soil is moderately deep to weathered bedrock and is well drained. It formed in a mixture of volcanic ash, pumice, and colluvium derived from granitic and low-grade metamorphic rocks. Typically, the surface is covered with a mat of needles, twigs, bark, and moss 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark reddish brown gravelly sandy loam. The upper 8 inches of the subsoil is dark yellowish brown very gravelly loamy sand. The lower 16 inches is olive brown extremely cobbly coarse sand. Highly weathered granodiorite is at a depth of about 30 inches. The depth to bedrock ranges from 20 to 40 inches. In some areas the surface layer is sandy loam, loamy sand, or gravelly loamy sand. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to andesite.

Permeability is moderately rapid in the Serene soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is granite or low-grade metamorphic rocks. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

This unit is used mainly as woodland. It also is used as a source of aggregate and for wildlife habitat.

Western hemlock and Pacific silver fir are the main

woodland species. Among the trees of limited extent are noble fir and mountain hemlock. The common forest understory plants are common beargrass, longtube twinflower, bunchberry dogwood, huckleberry, deer fern, princes pine, lupine, salal, cascade azalea, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of Pacific silver fir have not been made. Yields are reduced by the Rock outcrop, which makes up about 30 percent of this unit.

The main limitations affecting timber harvesting are the Rock outcrop, snowpack, the slope, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. The pattern of the Rock outcrop on the landscape, however, results in a discontinuous slope, which hinders the use of these systems. Trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The Serene soil is in capability subclass VIIs. The Rock outcrop is in capability subclass VIIIs.

235—Shalcar muck, 0 to 1 percent slopes. This very deep, very poorly drained soil is in depressions on outwash terraces, till plains, and stream terraces. It formed in herbaceous and woody organic deposits over alluvium and glaciofluvial deposits. The native vegetation is mainly shrubs, forbs, and trees. Elevation is 200 to 700 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface layer is very dark brown muck 10 inches thick. The upper 10 inches of the underlying material is very dark brown sapric material. The lower part to a depth of 60 inches is dark grayish brown sandy loam. In some areas the surface layer is hemic material. In other areas the lower part of the underlying material is below a depth of 51 inches.

Included in this unit are small areas of Seattle and Woodinville soils, ponded areas, drained Shalcar soils, and Shalcar soils that have slopes of more than 1 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Shalcar soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at or above the surface or within a depth of 1.5 feet from October through May. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly as woodland or for wildlife habitat. It also is used as pasture where drained.

In the areas used for hay and pasture, the main limitation is the seasonal high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in

compaction of the surface layer and poor tilth.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, lodgepole pine, and Sitka spruce. The common forest understory plants are sedges, rushes, hardhack, skunk cabbage, salmonberry, trailing blackberry, and devilsclub.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 85. The highest average growth rate in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the seasonal high water table and low strength. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIw.

236—Si silt loam, 0 to 2 percent slopes. This very deep, moderately well drained soil is on river terraces. It formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 500 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 150 days.

Typically, the surface layer is dark brown silt loam 11 inches thick. The subsoil is olive brown silt loam 11 inches thick. The substratum to a depth of 60 inches or more is light olive brown and olive brown, stratified silt loam and fine sandy loam. In some areas the surface layer is very fine sandy loam. In other areas the substratum does not have sandy material.

Included in this unit are small areas of Edgewick and Salal soils and Si soils that have slopes of more than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Si soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at a depth of 2 to 4 feet from November through April. Runoff is very slow, and there is no hazard of erosion. This soil is subject to occasional, brief periods of flooding from February through April.

This unit is used mainly as hayland, pasture, or cropland. It also is used as woodland and as a site for homes.

In the areas used for hay and pasture, the main limitation is the seasonal high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and help to control runoff and erosion.

The main limitation in the areas used as cropland is the seasonal high water table. This unit is suited to all of the crops commonly grown in the survey area. The principal crops are oats and corn silage. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, black cottonwood, and western redcedar. The common forest understory plants are western swordfern, trailing blackberry, salmonberry, and thimbleberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 160. On the basis of a 50-year site curve, it is estimated to be 120 for Douglas fir and 90 for red alder. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 170 cubic feet per acre per year, occurring at age 65. For red alder it is about 101 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and the flooding. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high

degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

In the areas used for homesite development, the main limitations are the flooding and the seasonal high water table. The seasonal high water table increases the likelihood that septic tank absorption fields will fail. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

This unit is in capability subclass IIIw.

237—Skykomish gravelly sandy loam, 0 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces and escarpments. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 130 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 10 inches, the surface layer is dark brown gravelly sandy loam. The upper 5 inches of the subsoil is yellowish red very gravelly sandy loam. The lower 9 inches is dark brown very gravelly loamy sand. The substratum to a depth of 60 inches is dark grayish brown and dark brown extremely gravelly coarse sand. The depth to extremely gravelly coarse sand ranges from 14 to 30 inches. In some areas the surface layer is very gravelly sandy loam or gravelly loam. In other areas the soil has a substratum of very gravelly sandy loam or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Elwell, Olomount, Philippa, Rober, and Teneriffe soils, stony areas, and Skykomish soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Skykomish soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are red huckleberry, western swordfern, western brackenfern, salal, and Oregongrape.

On the basis of a 100-year site curve, the mean site index is 148 for western hemlock and 138 for Douglas fir. On the basis of a 50-year site curve, it is 106 for western hemlock and 108 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 234 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 142 cubic feet per acre per year, occurring at age 70.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of

cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

238—Skykomish gravelly sandy loam, 30 to 65 percent slopes. This very deep, somewhat excessively drained soil is on terraces and escarpments. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 130 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 10 inches, the surface layer is dark brown gravelly sandy loam. The upper 5 inches of the subsoil is yellowish red very gravelly sandy loam. The lower 9 inches is dark brown very gravelly loamy sand. The substratum to a depth of 60 inches is dark grayish brown and dark brown extremely gravelly coarse sand. The depth to extremely gravelly coarse sand ranges from 14 to 30 inches. In some areas the surface layer is very gravelly sandy loam or gravelly loam. In other areas the soil has a substratum of very gravelly sandy loam or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Elwell, Olomount, Philippa, Rober, and Teneriffe soils, stony areas, and Skykomish soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Skykomish soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are red huckleberry, western swordfern, western brackenfern, salal, and Oregongrape.

On the basis of a 100-year site curve, the mean site index is 148 for western hemlock and 138 for Douglas fir. On the basis of a 50-year site curve, it is 106 for western hemlock and 108 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 234 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 142 cubic feet per acre per year, occurring at age 70.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

239—Skykomish gravelly sandy loam, windswept, 0 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces and escarpments. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 130 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 10 inches, the surface layer is dark brown

gravelly sandy loam. The upper 5 inches of the subsoil is yellowish red very gravelly sandy loam. The lower 9 inches is dark brown very gravelly loamy sand. The substratum to a depth of 60 inches is dark grayish brown and dark brown extremely gravelly coarse sand. The depth to extremely gravelly coarse sand ranges from 14 to 30 inches. In some areas the surface layer is very gravelly sandy loam or gravelly loam. In other areas the soil has a substratum of very gravelly sandy loam or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Elwell, Olomount, Philippa, Rober, and Teneriffe soils, stony areas, and Skykomish soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Skykomish soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar and red alder. The common forest understory plants are red huckleberry, western swordfern, western brackenfern, salal, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 120. On the basis of a 50-year site curve, it is estimated to be 85. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 180 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Douglas fir have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

240—Skykomish very stony loam, 0 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces and escarpments. It formed in a mixture of volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 45 degrees F. The average frost-free period is about 130 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown very stony loam 5 inches thick. The upper 8 inches of the subsoil is dark reddish brown very stony loam. The lower 9 inches is yellowish red very stony sandy loam. The substratum to a depth of 60 inches is dark grayish brown extremely stony sand. The depth to extremely stony sand ranges from 14 to 30 inches. In some areas the surface layer is very stony sandy loam or stony loam. In other areas the soil has a substratum of very stony or very gravelly sandy loam or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Elwell, Philippa, and Teneriffe soils and Skykomish soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Skykomish soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar and red

alder. The common forest understory plants are red huckleberry, western swordfern, western brackenfern, salal, and Oregongrape.

On the basis of a 100-year site curve, the mean site index is 148 for western hemlock and 138 for Douglas fir. On the basis of a 50-year site curve, it is 106 for western hemlock and 108 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 234 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 142 cubic feet per acre per year, occurring at age 70.

The main limitations affecting timber harvesting are the surface stones and occasional snowpack. The stones on the surface hinder yarding. When felled, the timber can break on the stones. During an average year, snowpack limits the use of equipment and restricts access from January through March. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Logging loads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Because of the surface stones, planting seedlings by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVs.

241—Snoqualmie loamy fine sand, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on river terraces. It formed in gravelly alluvium. The native vegetation is mainly trees and shrubs. Elevation is 800 to 1,700 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 0.5 inch thick. The surface layer is very dark grayish brown loamy fine sand 8 inches thick. The upper 28 inches of the underlying material is very dark gray extremely gravelly coarse sand. The lower part to a depth of 60 inches is very dark gray extremely cobbly coarse sand. In some areas the surface layer is gravelly loamy sand, gravelly loam, or very gravelly sandy loam. In other areas the substratum has 15 to 35 percent rock fragments. In places the soil has strata of sandy loam.

Included in this unit are small areas of Greenwater and Pilchuck soils, Riverwash, poorly drained mineral or organic soils in drainageways, and Snoqualmie soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the Snoqualmie soil. Available water capacity is low. The effective rooting depth is limited by an apparent high water table, which is at a depth of 3 to 5 feet from November through April. This soil is subject to occasional, brief periods of flooding from November through April. The flooding occurs during periods of snowmelt and rainfall. Runoff is very slow, and the hazard of water erosion is severe because of the susceptibility to flooding and channeling.

This unit is used as woodland or for wildlife habitat. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and black cottonwood. The common forest understory plants are western swordfern, vine maple, red huckleberry, longtube twinflower, trailing blackberry, thimbleberry, deer fern, trillium, bunchberry dogwood, Oregongrape, salmonberry, and deerfoot vanillaleaf.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 143. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65.

The main hazard affecting timber harvesting is the flooding. Equipment should be used only during dry periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. The seedling survival rate may be low where flooding occurs. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIw.

242—Snoqualmie loamy fine sand, windswept, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on river terraces. It formed in gravelly alluvium. The native vegetation is mainly trees and shrubs. Elevation is 800 to 1,700 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is very dark grayish brown loamy fine sand 8 inches thick. The upper 28 inches of the underlying material is very dark gray extremely gravelly coarse sand. The lower part to a depth of 60 inches is very dark gray extremely cobbly coarse sand. In some areas the surface layer is gravelly loamy sand, gravelly loam, or very gravelly sandy loam. In other areas the substratum has 15 to 35 percent rock fragments. In places the soil has strata of sandy loam.

Included in this unit are small areas of Greenwater and Pilchuck soils, Riverwash, poorly drained mineral or organic soils in drainageways, and Snoqualmie soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the Snoqualmie soil. Available water capacity is low. The effective rooting depth is limited by an apparent high water table, which is at a depth of 3 to 5 feet from November through April. This soil is subject to occasional, brief periods of flooding from November through April. The flooding occurs during periods of snowmelt and rainfall. Runoff is very slow, and the hazard of water erosion is severe because of the susceptibility to flooding and channeling.

This unit is used as woodland or for wildlife habitat. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and black cottonwood. The common forest understory plants are western swordfern, vine maple, red huckleberry, longtube twinflower, trailing blackberry, thimbleberry, deer fern, trillium, bunchberry dogwood, Oregongrape, salmonberry, and deerfoot vanillaleaf.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 110. On the basis of a 50-year site curve, it is estimated to be 85. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 98 cubic feet per acre per year, occurring at age 60. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main hazard affecting timber harvesting is the flooding. Equipment should be used only during dry periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. The seedling survival rate may be low where flooding occurs. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIw.

243—Spukwush loamy sand, 8 to 30 percent slopes. This very deep, well drained soil is in slump areas in the mountains. It formed in volcanic ash and cinders over highly weathered tuffaceous material. The native vegetation is mainly conifers and shrubs. Elevation is 2,700 to 4,000 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 120 days.

When mixed to a depth of 7 inches, the surface layer is strong brown loamy sand. The upper 8 inches of the subsoil is brown very cindery sandy loam. The lower 21 inches is yellowish brown and light yellowish brown loam. The upper 3 inches of the substratum is light yellowish brown loam. The lower part to a depth of 60 inches is light yellowish brown gravelly loam. In some

areas the surface layer is sandy loam. In other areas the soil has 25 to 60 percent rock fragments in the lower part of the substratum.

Included in this unit are small areas of Haywire, Nagrom, and Playco soils and Spukwush soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Spukwush soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is Douglas fir. The common forest understory plants are huckleberry, devilsclub, deer fern, evergreen huckleberry, currant, Oregongrape, western swordfern, western brackenfern, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 123. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 186 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock, Pacific silver fir, or Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of western hemlock seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIe.

244—Stahl very gravelly silt loam, 30 to 65 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and colluvium and residuum derived dominantly from andesite. The native vegetation is mainly conifers and shrubs. Elevation is 2,700 to 4,700 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of decomposed needles, leaves, and twigs 4 inches thick. The surface layer is dark brown very gravelly silt loam 8 inches thick. The subsoil also is dark brown very gravelly silt loam. It is 7 inches thick. The substratum is dark brown extremely cobbly silty clay loam 14 inches thick. Andesite is at a depth of about 29 inches. The depth to andesite ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock or is underlain by breccia.

Included in this unit are small areas of Nagrom, Reichel, and Spukwush soils and Stahl soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Stahl soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and western redcedar. The common forest understory plants are Oregongrape, bunchberry dogwood, queencup beadlily, red huckleberry, violet, Pacific

trillium, western rattlesnake plantain, salal, common beargrass, western swordfern, American trailplant, western brackenfern, vine maple, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index is 130 for western hemlock and 124 for Douglas fir. On the basis of a 50-year site curve, it is 91 for western hemlock and 95 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 200 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 121 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock, Douglas fir, noble fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of western hemlock seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

245—Stahl very gravelly silt loam, tuff substratum, 15 to 30 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and colluvium and residuum derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 2,700 to 4,700 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of decomposed needles, leaves, and twigs 8 inches thick. The surface layer is very dark brown very gravelly silt loam 7 inches thick. The upper 10 inches of the subsoil is dark brown very gravelly silt loam. The lower 18 inches is dark brown extremely gravelly silt loam. Breccia is at a depth of about 35 inches. The depth to breccia or tuff ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock or is underlain by andesite.

Included in this unit are small areas of Nagrom, Reichel, and Spukwush soils and Stahl soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Stahl soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and western redcedar. The common forest understory plants are Oregongrape, bunchberry dogwood, queencup beadlily, red huckleberry, violet, Pacific trillium, western rattlesnake plantain, salal, common beargrass, western swordfern, American trailplant, western brackenfern, vine maple, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index is 130 for western hemlock and 124 for Douglas fir. On the basis of a 50-year site curve, it is 91 for western hemlock and 95 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 200 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 121 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the hazard of erosion. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock, Douglas fir, noble fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of western hemlock seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIe.

246—Stahl very gravelly silt loam, tuff substratum, 30 to 65 percent slopes. This well drained soil is on mountain back slopes. It is moderately deep to bedrock. It formed in a mixture of volcanic ash and colluvium and residuum derived dominantly from breccia and tuff. The native vegetation is mainly conifers and shrubs. Elevation is 2,700 to 4,700 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of decomposed needles, leaves, and twigs 8 inches thick. The surface layer is very dark brown very gravelly silt loam 7 inches thick. The upper 10 inches of the subsoil is dark brown very gravelly silt loam. The lower 18 inches is dark brown extremely gravelly silt loam. Breccia is at a depth of about 35 inches. The depth to breccia or tuff ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock or is underlain by andesite.

Included in this unit are small areas of Nagrom, Reichel, and Spukwush soils and Stahl soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Stahl soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock, Douglas fir, and Pacific silver fir are the main woodland species. Among the trees of limited extent are noble fir and western redcedar. The common forest understory plants are Oregongrape, bunchberry dogwood, queencup beadlily, red huckleberry, violet, Pacific trillium, western rattlesnake plantain, salal, common beargrass, western swordfern, American trailplant, western brackenfern, vine maple, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index is 130 for western hemlock and 124 for Douglas fir. On the basis of a 50-year site curve, it is 91 for western hemlock and 95 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 200 cubic feet per acre per year, occurring at age 50. For Douglas fir it is 121 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality breccia or tuff. Extra rock is needed to maintain a stable

and uniform road surface. Cut and fill slopes tend to slump when wet. Roads and cut and fill slopes are subject to failure as a result of the instability of the underlying tuff or breccia.

Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock, Douglas fir, noble fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of western hemlock seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

247—Sulsavar loam, 0 to 8 percent slopes. This very deep, well drained soil is on alluvial fans and terraces. It formed in volcanic ash and alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 1,100 to 1,500 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and moss 2 inches thick. The surface layer is dark brown loam 28 inches thick. The subsoil is yellowish brown sandy loam 19 inches thick. The upper 4 inches of the substratum is dark yellowish brown and yellowish brown loam. The lower part to a depth of 60 inches is dark brown and dark yellowish brown very gravelly loam. In some areas the surface layer is silt loam or sandy loam.

Included in this unit are small areas of Klaus and Winston soils, soils that are very gravelly sand in the lower part of the substratum, and Sulsavar soils that have slopes of more than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the Sulsavar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare flooding.

This unit is used mainly as woodland. It also is used as hayland, pasture, or cropland.

In the areas used for hay and pasture, the main hazard is the flooding. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and help to control runoff and erosion.

The main hazard in the areas used as cropland is the flooding. This unit is suited to all of the crops commonly grown in the survey area. The principal crops are oats and corn silage. In summer, irrigation is required for maximum production.

Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder and western redcedar. The common forest understory plants are western swordfern, red huckleberry, vine maple, ladyfern, trailing blackberry, salal, and Oregongrape.

On the basis of a 100-year site curve, the mean site index is 183 for Douglas fir and 178 for western hemlock. On the basis of a 50-year site curve, it is 142 for Douglas fir and 124 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 194 cubic feet per acre per year, occurring at age 60. For western hemlock it is 288 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and

gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of Douglas fir seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIe.

248—Sultan silt loam, 0 to 2 percent slopes. This very deep, moderately well drained soil is on river terraces. It formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 120 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 175 days.

Typically, the surface layer is very dark grayish brown silt loam 9 inches thick. The upper 15 inches of the subsoil is yellowish brown silty clay loam and light olive brown silt loam. The lower 24 inches is grayish brown, mottled silty clay loam. The substratum to a depth of 60 inches is olive gray, mottled very fine sandy loam stratified with sand. In some areas the surface layer is very fine sandy loam. In other areas the soil has sand at a depth of 40 to 60 inches.

Included in this unit are small areas of Belfast, Nooksack, Puget, and Woodinville soils and Sultan soils that have slopes of more than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Sultan soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at a depth of 2 to 4 feet from November through April. Runoff is very slow, and there is no hazard of erosion. This soil is subject to rare flooding.

This unit is used mainly as hayland, pasture, or cropland. It also is used as a site for homes.

In the areas used for hay and pasture, the main limitation is the seasonal high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and help to control runoff and erosion.

The main limitation in the areas used as cropland is the seasonal high water table. This unit is suited to all of the crops commonly grown in the survey area. The principal crops are oats and corn silage. In summer, irrigation is required for maximum production.

Douglas fir and red alder are the main woodland species. Among the trees of limited extent is western redcedar. The common forest understory plants are vine maple, willows, western swordfern, salmonberry, Oregongrape, thimbleberry, stinging nettle, bedstraw, western brackenfern, trailing blackberry, and trillium.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 160. On the basis of a 40-year site curve, it is estimated to be 120. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 170 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, red alder, or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

In the areas used for homesite development, the main limitations are the flooding and the seasonal high water table. The seasonal high water table increases the likelihood that septic tank absorption fields will fail. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

This unit is in capability subclass IIw.

249—Teneriffe loamy sand, 8 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice over

colluvium derived dominantly from granite and low-grade metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown loamy sand. The upper 4 inches of the subsoil also is dark brown loamy sand. The next 10 inches is strong brown gravelly loamy sand. The lower 16 inches is olive brown and light olive brown very gravelly loamy sand. The substratum to a depth of 60 inches is light yellowish brown very gravelly coarse sand. In some areas the surface layer is sandy loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Marblemount and Philippa soils and Teneriffe soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid in the Teneriffe soil. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are vine maple, salal, Oregongrape, western swordfern, red huckleberry, western brackenfern, trailing blackberry, longtube twinflower, queencup beadlily, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 143. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs periodically.

This unit is in capability subclass IVe.

250—Teneriffe loamy sand, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice over colluvium derived dominantly from granite and low-grade metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown loamy sand. The upper 4 inches of the subsoil also is dark brown loamy sand. The next 10 inches is strong brown gravelly loamy sand. The lower 16 inches is olive brown and light olive brown very gravelly loamy sand. The substratum to a depth of 60 inches is light yellowish brown very gravelly coarse sand. In some areas the surface layer is sandy loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Marblemount and Philippa soils and Teneriffe soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid in the Teneriffe soil. Available water capacity is low. The effective rooting depth is 60

inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are vine maple, salal, Oregongrape, western swordfern, red huckleberry, western brackenfern, trailing blackberry, longtube twinflower, queencup beadlily, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 143. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs periodically.

This unit is in capability subclass VIIe.

251—Teneriffe loamy sand, windswept, 30 to 65 percent slopes. This deep and very deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice over colluvium derived dominantly from granite and low-grade metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown loamy sand. The upper 4 inches of the subsoil also is dark brown loamy sand. The next 10 inches is strong brown gravelly loamy sand. The lower 16 inches is olive brown and light olive brown very gravelly loamy sand. The substratum to a depth of 60 inches is light yellowish brown very gravelly coarse sand. In some areas the surface layer is sandy loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Marblemount and Philippa soils and Teneriffe soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid in the Teneriffe soil. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are vine maple, salal, Oregongrape, western swordfern, red huckleberry, western brackenfern, trailing blackberry, longtube twinflower, queencup beadlily, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 117. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope

restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality granite. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs periodically.

This unit is in capability subclass VIIe.

252—Teneriffe very gravelly sandy loam, channery substratum, 8 to 30 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice over colluvium derived dominantly from low-grade metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very gravelly sandy loam. The subsoil is yellowish brown very gravelly loamy sand 5 inches thick. The substratum is light yellowish brown extremely channery loamy sand 36 inches thick. Weathered shale is at a depth of about 47 inches. The depth to shale, phyllite, or slate ranges from 40 to 60 inches. In some areas the surface layer is gravelly sandy loam or very gravelly loamy sand. In other areas the soil is more than 60 inches deep over bedrock.

Included in this unit are small areas of Marblemount and Philippa soils and Teneriffe soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid in the Teneriffe soil. Available water capacity is low. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are vine maple, salal, Oregongrape, western swordfern, red huckleberry, western brackenfern, trailing blackberry, longtube twinflower, queencup beadlily, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 143. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality shale, phyllite, and slate. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the

survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs periodically.

This unit is in capability subclass IVe.

253—Teneriffe very gravelly sandy loam, channery substratum, 30 to 65 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in volcanic ash and pumice over colluvium derived dominantly from low-grade metamorphic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 110 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, twigs, and moss 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very gravelly sandy loam. The subsoil is yellowish brown very gravelly loamy sand 5 inches thick. The substratum is light yellowish brown extremely channery loamy sand 36 inches thick. Weathered shale is at a depth of about 47 inches. The depth to shale, phyllite, or slate ranges from 40 to 60 inches. In some areas the surface layer is gravelly sandy loam or very gravelly loamy sand. In other areas the soil is more than 60 inches deep over bedrock.

Included in this unit are small areas of Marblemount and Philippa soils and Teneriffe soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is rapid in the Teneriffe soil. Available water capacity is low. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are vine maple, salal, Oregongrape, western swordfern, red huckleberry, western brackenfern, trailing blackberry, longtube twinflower, queencup beadlily, and deer fern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 143. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 149 cubic feet per acre per year, occurring at age 65. Estimates of the site index and growth rate of western hemlock have not been made.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality shale, phyllite, and slate. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs periodically.

This unit is in capability subclass VIIe.

254—Tokul gravelly loam, 0 to 6 percent slopes. This moderately well drained soil is on mountain foot slopes and in valleys. It is moderately deep to ortstein. It formed in a mixture of volcanic ash and dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,100 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 0.5 inch thick. The surface layer is very dark brown gravelly loam 3 inches thick. The subsoil is dark yellowish brown gravelly loam 28 inches thick. The substratum is dark yellowish brown gravelly fine sandy loam 6 inches thick. Dark grayish

brown ortstein that crushes to very gravelly sandy loam is at a depth of about 37 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam, silt loam, or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil or is 40 to 60 inches deep to ortstein.

Included in this unit are small areas of Barneston, Beausite, Norma, and Pastik soils and Tokul soils that have slopes of more than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Tokul soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture.

In the areas used for hay and pasture, the main limitations are the seasonal high water and the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water.

Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, western brackenfern, red huckleberry, salal, trailing blackberry, salmonberry, vine maple, deer fern, ladyfern, Oregongrape, and Pacific trillium.

On the basis of a 100-year site curve, the mean site index is 172 for Douglas fir and 166 for western hemlock. On the basis of a 50-year site curve, it is 130 for Douglas fir and 117 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 183 cubic feet per acre per year, occurring at age 60. For western hemlock it is 266 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IIIe.

255—Tokul gravelly loam, 6 to 15 percent slopes. This moderately well drained soil is on mountain foot slopes and in valleys. It is moderately deep to ortstein. It formed in a mixture of volcanic ash and dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,100 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 0.5 inch thick. The surface layer is very dark brown gravelly loam 3 inches thick. The subsoil is dark yellowish brown gravelly loam 28 inches thick. The substratum is dark yellowish brown gravelly fine sandy loam 6 inches thick. Dark grayish brown ortstein that crushes to very gravelly sandy loam is at a depth of about 37 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam, silt loam, or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil or is 40 to 60 inches deep to ortstein.

Included in this unit are small areas of Barneston, Beausite, Norma, and Pastik soils and Tokul soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Tokul soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through May. In most areas, runoff is slow

and the hazard of water erosion is slight. In areas used as pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used mainly as woodland. It also is used for hay and pasture.

In the areas used for hay and pasture, the main limitations are the seasonal high water and the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water.

Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, western brackenfern, red huckleberry, salal, trailing blackberry, salmonberry, vine maple, deer fern, ladyfern, Oregongrape, and Pacific trillium.

On the basis of a 100-year site curve, the mean site index is 172 for Douglas fir and 166 for western hemlock. On the basis of a 50-year site curve, it is 130 for Douglas fir and 117 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 183 cubic feet per acre per year, occurring at age 60. For western hemlock it is 266 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IIIe.

256—Tokul gravelly loam, 15 to 30 percent slopes. This moderately well drained soil is mountain foot slopes and in valleys. It is moderately deep to ortstein. It formed in a mixture of volcanic ash and dense glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,100 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 0.5 inch thick. The surface layer is very dark brown gravelly loam 3 inches thick. The subsoil is dark yellowish brown gravelly loam 28 inches thick. The substratum is dark yellowish brown gravelly fine sandy loam 6 inches thick. Dark grayish brown ortstein that crushes to very gravelly sandy loam is at a depth of about 37 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam, silt loam, or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil or is 40 to 60 inches deep to ortstein.

Included in this unit are small areas of Barneston, Beausite, Norma, and Pastik soils and Tokul soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Tokul soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, western brackenfern, red huckleberry, salal, trailing blackberry, salmonberry, vine maple, deer fern, ladyfern, Oregongrape, and Pacific trillium.

On the basis of a 100-year site curve, the mean site index is 172 for Douglas fir and 166 for western hemlock. On the basis of a 50-year site curve, it is 130 for Douglas fir and 117 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 183 cubic feet per acre per

year, occurring at age 60. For western hemlock it is 266 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IVe.

257—Tokul gravelly loam, 30 to 65 percent slopes. This moderately well drained soil is on mountain foot slopes and in valleys. It is moderately deep to ortstein. It formed in a mixture of volcanic ash and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,100 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 0.5 inch thick. The surface layer is very dark brown gravelly loam 3 inches thick. The subsoil is dark yellowish brown gravelly loam 28 inches thick. The substratum is dark yellowish brown gravelly fine sandy loam 6 inches thick. Dark grayish brown ortstein that crushes to very gravelly sandy loam is below a depth of about 37 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam, silt loam, or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil or is 40 to 60 inches deep to ortstein.

Included in this unit are small areas of Barneston, Beausite, and Pastik soils and Tokul soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Tokul soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through May. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, western brackenfern, red huckleberry, salal, trailing blackberry, salmonberry, vine maple, deer fern, ladyfern, Oregongrape, and Pacific trillium.

On the basis of a 100-year site curve, the mean site index is 172 for Douglas fir and 166 for western hemlock. On the basis of a 50-year site curve, it is 130 for Douglas fir and 117 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 183 cubic feet per acre per year, occurring at age 60. For western hemlock it is 266 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the ortstein, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass VIIe.

258—Tokul-Pastik complex, 45 to 90 percent slopes. This map unit is on terrace escarpments and mountain foot slopes. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,100 feet. The average annual precipitation is about 65 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 160 days.

This unit is 50 percent Tokul gravelly loam and 25 percent Pastik silt loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Barneston and Nargar soils and Tokul and Pastik soils that have slopes of less than 45 percent. Included areas make up about 25 percent of the total acreage.

The Tokul soil is moderately deep to ortstein and is moderately well drained. It formed in a mixture of volcanic ash and dense glacial till. Typically, the surface is covered with a mat of needles, leaves, and twigs 0.5 inch thick. The surface layer is very dark brown gravelly loam 3 inches thick. The subsoil is dark yellowish brown gravelly loam 28 inches thick. The substratum is dark yellowish brown gravelly fine sandy loam 6 inches thick. Dark grayish brown ortstein that crushes to very gravelly sandy loam is at a depth of about 37 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam, silt loam, or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil or is 40 to 60 inches deep to ortstein.

Permeability is moderate in the upper part of the Tokul soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through May. Runoff is rapid, and the hazard of water erosion is severe.

The Pastik soil is very deep and moderately well drained. It formed in lake sediments and volcanic ash. Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown silt loam 6 inches thick. The upper 6 inches of the subsoil also is dark brown silt loam. The lower 19 inches is dark yellowish brown and yellowish brown very fine sandy loam. The substratum to a depth of 60 inches is olive brown and light brownish gray silt loam. In some areas the surface layer is sandy loam or loam. In other areas the substratum is silty clay.

Permeability is slow in the Pastik soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 1.5 to 2.5 feet from December through May. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, red huckleberry, ladyfern, vine maple, salal, deer fern, salmonberry, western brackenfern, trailing blackberry, ladyfern, Pacific trillium, and Oregongrape.

On the basis of a 100-year site curve, the mean site index on the Tokul soil is 172 for Douglas fir and 166 for western hemlock. On the basis of a 50-year site curve, it is 130 for Douglas fir and 117 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 183 cubic feet per acre per year, occurring at age 60. For western hemlock it is 266 cubic feet per acre per year, occurring at age 50.

On the basis of a 100-year site curve, the mean site index on the Pastik soil is 177 for Douglas fir and 176 for western hemlock. On the basis of a 50-year site curve, it is 132 for Douglas fir and 123 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 188 cubic feet per acre per year, occurring at age 60. For western hemlock it is 285 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and

filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of soil compaction when the soils are moist and a high degree of puddling when the soils are wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Tokul and Pastik soils are in capability subclass VIIe.

259—Tokul-Pastik complex, windswept, 45 to 90 percent slopes. This map unit is on terrace escarpments and mountain foot slopes. The native vegetation is mainly conifers and shrubs. Elevation is 800 to 1,100 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

This unit is 50 percent Tokul gravelly loam and 25 percent Pastik silt loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale.

Included in this unit are small areas of Barneston and Nargar soils and Tokul and Pastik soils that have slopes of less than 45 percent. Included areas make up about 25 percent of the total acreage.

The Tokul soil is moderately deep to ortstein and is moderately well drained. It formed in a mixture of volcanic ash and dense glacial till. Typically, the surface is covered with a mat of needles, leaves, and twigs 0.5 inch thick. The surface layer is very dark brown gravelly loam 3 inches thick. The subsoil is dark yellowish brown gravelly loam 28 inches thick. The substratum is dark yellowish brown gravelly fine sandy loam 6 inches thick. Dark grayish brown ortstein that crushes to very gravelly sandy loam is at a depth of about 37 inches. The depth to ortstein ranges from 20 to 40 inches. In some areas the surface layer is loam, silt loam, or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil or is 40 to 60 inches deep to ortstein.

Permeability is moderate in the upper part of the Tokul soil and very slow in the ortstein. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the ortstein from November through May. Runoff is rapid, and the hazard of water erosion is severe.

The Pastik soil is very deep and moderately well drained. It formed in lake sediments and volcanic ash. Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown silt loam 6 inches thick. The upper 6 inches of the subsoil also is dark brown silt loam. The lower 19 inches is dark yellowish brown and yellowish brown very fine sandy loam. The substratum to a depth of 60 inches is olive brown and light brownish gray very fine sandy loam. In some areas the surface layer is sandy loam or loam. In other areas the substratum is silty clay.

Permeability is slow in the Pastik soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 2.5 feet from December through May. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, red huckleberry, ladyfern, vine maple, salal, deer fern, salmonberry, western brackenfern, trailing blackberry, ladyfern, Pacific trillium, and Oregongrape.

On the basis of a 100-year site curve, the mean site index on both soils for Douglas fir is estimated to be 137. On the basis of a 50-year site curve, it is estimated to be 105. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 140 cubic feet per acre per year, occurring at age 70. Estimates of the site index and growth rate of western hemlock have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems

generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of soil compaction when the soils are moist and a high degree of puddling when the soils are wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

This unit is in capability subclass VIIe.

260—Treen loam, 30 to 90 percent slopes. This well drained soil is on mountain back slopes and ridge crests. It is shallow to bedrock. It formed in a mixture of volcanic ash and material weathered from various rock types. The native vegetation is mainly forbs. Elevation is 3,200 to 5,000 feet. The average annual precipitation is about 100 inches, and the average annual air temperature is about 40 degrees F. The average frost-free period is about 90 days.

Typically, the surface is covered with a mat of organic material 2 inches thick. The upper 5 inches of the surface layer is very dark grayish brown loam. The lower 9 inches is dark brown sandy loam. The subsoil is brown gravelly sandy loam 4 inches thick. Schist is at a depth of about 18 inches. The depth to bedrock ranges from 14 to 20 inches. In some areas the surface layer is sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the lower part of the subsoil and in the substratum.

Included in this unit are small areas of Haywire soils, avalanche chutes, and Treen soils that have slopes of less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Treen soil. Available water capacity is low. The effective rooting depth is 14 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for wildlife habitat.

This unit is in capability subclass VIIe.

261—Tukwila muck, 0 to 1 percent slopes. This very deep, very poorly drained soil is in depressions on stream terraces. It formed in herbaceous and woody organic deposits stratified with mineral layers. The native vegetation is mainly shrubs, forbs, and trees. Elevation is 100 to 500 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 170 days.

Typically, the surface layer is black muck 10 inches thick. The upper 31 inches of the underlying material is black and dark reddish brown sapric material. The lower part to a depth of 60 inches is dark brown, dark reddish brown, and gray, stratified mineral and sapric material. In some areas the surface layer is hemic material. In other areas the lower part of the underlying material is all mineral or all sapric material.

Included in this unit are small areas of Norma and Woodinville soils, ponded areas, and drained Tukwila soils. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Tukwila soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at or above the surface or within a depth of 1 foot from October through May. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly for wildlife habitat. It also is used as woodland. Drained areas are used for hay and pasture.

In the areas used for hay and pasture, the main limitations are the high water table and low strength. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, and Sitka spruce. The common forest understory plants are western swordfern, devilsclub, vine maple, sedges, and rushes.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 85. The highest average growth rate in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the seasonal high water table and low strength. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seeding establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass Vw.

262—Tusip sandy loam, 15 to 30 percent slopes. This deep, well drained soil is on mountain back slopes and rounded ridgetops. It formed in volcanic ash, pumice, and cinders over residuum and colluvium derived from weathered sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 2,700 to 3,600 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 130 days.

Typically, the surface is covered with a mat of needles, leaves, bark, and moss 1 inch thick. When mixed to a depth of 6 inches, the surface layer is dark brown sandy loam. The upper 9 inches of the subsoil is strong brown loamy sand. The next 23 inches is yellowish brown gravelly sandy loam and gravelly fine sandy loam. The lower 5 inches is yellowish brown very gravelly fine sandy loam. Weathered sandstone is at a depth of about 43 inches. The depth to weathered sandstone ranges from 40 to 60 inches. In some areas the surface layer is cindery loam or cindery sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the substratum or is more than 60 inches deep to sandstone.

Included in this unit are small areas of Cattcreek, Cotteral, Nagrom, and Playco soils and Tusip soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Tusip soil. Available water capacity also is moderate. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is Douglas fir. The common forest understory plants are salal, tall blue huckleberry, deer fern, western swordfern, common beargrass, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 123. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 186 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is

poor-quality sandstone. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion. Cinders readily slough from cuts onto the road surface.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit.

This unit is in capability subclass VIe.

263—Tusip sandy loam, 30 to 65 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in volcanic ash, pumice, and cinders over residuum and colluvium derived from weathered sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 2,700 to 3,600 feet. The average annual precipitation is about 90 inches, and the average annual air temperature is about 42 degrees F. The average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, bark, and moss 1 inch thick. When mixed to a depth of 6 inches, the surface layer is dark brown sandy loam. The upper 9 inches of the subsoil is strong brown loamy sand. The next 23 inches is yellowish brown gravelly sandy loam and gravelly fine sandy loam. The lower 5 inches is yellowish brown very gravelly fine sandy loam. Weathered sandstone is at a depth of about 43 inches. The depth to weathered sandstone ranges from 40 to 60 inches. In some areas the surface layer is cindery loam or cindery sandy loam. In other areas the soil has 15 to 35 percent rock fragments in the substratum or is more than 60 inches deep to sandstone.

Included in this unit are small areas of Cattcreek, Cotteral, Nagrom, and Playco soils and Tusip soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Tusip soil. Available water capacity also is moderate. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is Douglas fir. The common forest understory plants are salal, tall blue huckleberry, deer fern, western swordfern, common beargrass, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 123. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 186 cubic feet per acre per year, occurring at age 50. Estimates of the site index and growth rate of Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to ravel when dry. Establishing a plant cover in these disturbed areas reduces the hazard of erosion.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soil is moist, a moderate degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and naturally occurring seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This unit is in capability subclass VIIe.

264—Typic Haplorthods, 35 to 100 percent slopes. These moderately deep and deep, well drained soils are on mountainsides and canyonsides. They formed in volcanic ash, glacial drift, and colluvium. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 2,500 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 47 degrees F, and the average annual soil temperature ranges from 45 to 49 degrees F. The average frost-free period is about 140 days.

No single profile is representative of these soils. One of the more commonly observed ones, however, is covered with a mat of leaves and twigs about 2 inches thick. Typically, the surface layer is very dark grayish brown very gravelly loam 3 inches thick. The upper 19 inches of the subsoil is dark brown very gravelly loam. The lower 10 inches is olive brown very gravelly loam. The substratum is dark brown and light olive brown very gravelly loam. Grayish brown, dense glacial till that crushes to extremely gravelly loamy sand is at a depth of about 45 inches. The dense glacial till is similar to a cemented pan. The depth to dense glacial till or bedrock ranges from 20 to 60 inches. The content of clay ranges from 5 to 20 percent.

Included in this unit are small areas of Alderwood, Barneston, Elwell, Littlejohn, Lynnwood, Ovall, and Pitcher soils. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the Typic Haplorthods. Available water capacity also is moderate. The effective rooting depth is more than 20 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are bigleaf maple and western redcedar. The common forest understory plants are western swordfern, Oregongrape, red huckleberry, and salal.

On the basis of a 100-year site curve, the mean site index is estimated to be 149 for Douglas fir and 150 for western hemlock. On the basis of a 50-year site curve, it is estimated to be 115 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 151 cubic feet per acre per year, occurring at age 60. For western hemlock it is 238 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. During an average year, snowpack limits the use of equipment and restricts access in January and February. Unsurfaced roads are slippery and soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is generally not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely to occur. The areas most susceptible to landslides are those underlain by dense glacial till. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soils are moist, a moderate degree of puddling when the soils are wet, and a moderate degree of soil displacement when the soils are dry. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and displacement and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling mortality and establishment are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of

seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

265—Typic Udifluvents, 0 to 3 percent slopes. These very deep, well drained soils are on low stream terraces and in drainageways. They formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 2,500 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 150 days.

No single profile is representative of these soils. One of the more commonly observed ones, however, is covered with a mat of needles, leaves, and twigs 0.5 inch thick. Typically, the surface layer is very dark brown silt loam 5 inches thick. The subsoil is dark yellowish brown silt loam 11 inches thick. The substratum to a depth of 60 inches is dark yellowish brown, stratified fine sandy loam and sandy loam. The depth to stratified, loamy or sandy material ranges from 15 to 50 inches. In some areas the surface layer is very fine sandy loam.

Included in this unit are small areas of soils that are similar to the Typic Udifluvents but are more poorly drained, organic soils, and Typic Udifluvents that have slopes of more than 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Typic Udifluvents. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is very slow, and there is no hazard of erosion. These soils are subject to frequent, brief periods of flooding from December through April.

This unit is used mainly as woodland. In some areas it is used as hayland or pasture.

This unit is well suited to hay and pasture. The main hazard is the occasional flooding. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and help to control runoff and erosion. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are vine maple, willows, western swordfern, salmonberry, Oregongrape, thimbleberry, stinging nettle, bedstraw, western brackenfern, trailing blackberry, and trillium.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 167. On the basis of a 50-year site curve, it is estimated to be 125. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 178 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and the flooding. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soils are moist, a high degree of puddling when the soils are wet, and a moderate degree of soil displacement when the soils are dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVw.

266—Typic Udifluvents, windswept, 0 to 3 percent slopes. These very deep, well drained soils are on low stream terraces and in drainageways. They formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 2,500 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 46 degrees F. The average frost-free period is about 150 days.

No single profile is representative of these soils. One of the more commonly observed ones, however, is covered with a mat of needles, leaves, and twigs 0.5 inch thick. Typically, the surface layer is very dark brown silt loam 5 inches thick. The subsoil is dark yellowish brown silt loam 11 inches thick. The substratum to a depth of 60 inches is dark yellowish brown, stratified fine sandy loam and sandy loam. The depth to stratified, loamy or sandy material ranges from 15 to 50 inches. In some areas the surface layer is very fine sandy loam.

Included in this unit are small areas of soils that are similar to the Typic Udifluvents but are more poorly drained, organic soils, and Typic Udifluvents that have slopes of more than 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Typic Udifluvents. Available water capacity also is moderate. The effective rooting depth is 60 inches or more. Runoff is very slow, and there is no hazard of erosion. These soils are subject to frequent, brief periods of flooding from December through April.

This unit is used mainly as woodland. In some areas it is used as hayland or pasture.

This unit is well suited to hay and pasture. The main hazard is the occasional flooding. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and help to control runoff and erosion. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are vine maple, willows, western swordfern, salmonberry, Oregongrape, thimbleberry, stinging nettle, bedstraw, western brackenfern, trailing blackberry, and trillium.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 118. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 111 cubic feet per acre per year, occurring at age 60. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and the flooding. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soils are moist, a high degree of puddling when the soils are wet, and a moderate degree of soil displacement when the soils are dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVw.

267—Udifluvents, moist, 0 to 8 percent slopes. These very deep, well drained soils are on low stream terraces and in drainageways. They formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 1,300 to 2,500 feet. The average annual precipitation is about 70 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 150 days.

No single profile is representative of these soils. One of the more commonly observed ones, however, is covered with a mat of needles, leaves, and twigs 2 inches thick. Typically, the surface layer is very dark grayish brown and dark brown gravelly sandy loam 6 inches thick. The upper 15 inches of the underlying material is dark brown very gravelly loamy sand. The lower part to a depth of 60 inches is brown, stratified extremely gravelly sandy loam and extremely gravelly sandy clay loam. The depth to stratified, loamy or sandy, gravelly material is 15 to 50 inches. In some areas the surface layer is sandy loam, loam, or silt loam.

Included in this unit are small areas of Ohop soils, soils that are similar to the Udifluvents but have a water table at a depth of 2 to 5 feet, and organic soils. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid or rapid in the Udifluvents. Available water capacity is low. The effective rooting depth is 60 inches or more. Runoff is very slow, and there is no hazard of erosion. These soils are subject to occasional, brief periods of flooding from December through April.

This unit is used as woodland. Western hemlock, red alder, and Douglas fir are the main woodland species. Among the trees of limited extent is western redcedar. The common forest understory plants are vine maple, western swordfern, red huckleberry, Oregongrape, longtube twinflower, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index is estimated to be 138 for western hemlock and 149 for Douglas fir. On the basis of a 50-year site curve, it is estimated to be 100 for western hemlock and

red alder and 115 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 274 cubic feet per acre per year, occurring at age 50. For red alder it is about 118 cubic feet per acre per year, occurring at age 40. For Douglas fir it is about 157 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are occasional snowpack and the flooding. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil compaction when the soils are moist, a moderate degree of puddling when the soils are wet, and a moderate degree of soil displacement when the soils are dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by red alder and western hemlock occurs readily.

This unit is in capability subclass VIw.

268—Vailton silt loam, 8 to 30 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash and colluvium and residuum derived from siltstone and sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 10 inches, the upper part of the surface layer is dark brown silt loam. The lower 5 inches is brown silt loam. The upper 22 inches of the subsoil is dark yellowish brown silt loam. The lower 6 inches is dark brown silty clay loam. Weathered sandstone is at a depth of about 43 inches. The depth to weathered sandstone ranges from 40 to 60 inches. In some areas the surface layer is loam. In other areas the soil has a seasonal high water table at a depth of 40 to 60 inches from December through April or is more than 60 inches deep over bedrock.

Included in this unit are small areas of Jonas and Pheeney soils and Vailton soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Vailton soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are Oregongrape, deer fern, Oregon fairybells, Oregon oxalis, western swordfern, western brackenfern, red elderberry, Pacific trillium, red huckleberry, violet, Pacific yew, salal, vine maple, and salmonberry.

On the basis of a 100-year site curve, the mean site index is 141 for Douglas fir and 146 for western hemlock. On the basis of a 50-year site curve, it is 113 for Douglas fir and 103 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 146 cubic feet per acre per year, occurring at age 65. For western hemlock it is 230 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting

timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

269—Vailton silt loam, 30 to 65 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash and colluvium and residuum derived from siltstone and sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 10 inches, the upper part of the surface layer is dark brown silt loam. The lower 5 inches is brown silt loam. The upper 22 inches of the subsoil is dark yellowish brown silt loam. The lower 6 inches is dark brown silty clay loam. Weathered sandstone is at a depth of about 43 inches. The depth to weathered sandstone ranges from 40 to 60 inches. In some areas the surface layer is loam. In other areas the soil has a seasonal high water table at a depth of 40 to 60 inches from December through April or is more than 60 inches deep over bedrock.

Included in this unit are small areas of Jonas and Pheeney soils and Vailton soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Vailton soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are Oregongrape, deer fern, Oregon fairybells, Oregon oxalis, western swordfern, western brackenfern, red elderberry, Pacific trillium, red huckleberry, violet, Pacific yew, salal, vine maple, and salmonberry.

On the basis of a 100-year site curve, the mean site index is 141 for Douglas fir and 146 for western hemlock. On the basis of a 50-year site curve, it is 113 for Douglas fir and 103 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 146 cubic feet per acre per year, occurring at age 65. For western hemlock it is 230 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

270—Voight silt loam, 6 to 15 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in residuum and colluvium derived dominantly from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and bark 10 inches thick. The surface layer is very dark grayish brown silt loam 11 inches thick. The upper 32 inches of the subsoil is

brown silty clay loam. The lower 15 inches is reddish brown silty clay loam. The substratum to a depth of 60 inches is dark reddish brown and brown silt loam. In some areas the surface layer is silty clay loam, loam, or sandy loam. In other areas the soil has 15 to 35 percent weathered rock fragments in the subsoil and substratum or has 10 to 18 percent clay in the subsoil.

Included in this unit are small areas of Jonas, Pheeney, Scamman, and Zynbar soils and Voight soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Voight soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, vine maple, salal, Oregongrape, western brackenfern, Oregon oxalis, trailing blackberry, deer fern, red huckleberry, and Pacific trillium.

On the basis of a 100-year site curve, the mean site index is 145 for Douglas fir and 148 for western hemlock. On the basis of a 50-year site curve, it is 114 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 152 cubic feet per acre per year, occurring at age 60. For western hemlock it is 234 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

271—Voight silt loam, 15 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in residuum and colluvium derived dominantly from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and bark 10 inches thick. The surface layer is very dark grayish brown silt loam 11 inches thick. The upper 32 inches of the subsoil is brown silty clay loam. The lower 15 inches is reddish brown silty clay loam. The substratum to a depth of 60 inches is dark reddish brown and brown silt loam. In some areas the surface layer is silty clay loam, loam, or sandy loam. In other areas the soil has 15 to 35 percent weathered rock fragments in the subsoil and substratum or has 10 to 18 percent clay in the subsoil.

Included in this unit are small areas of Jonas, Pheeney, Scamman, and Zynbar soils and Voight soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Voight soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, vine maple, salal, Oregongrape, western brackenfern, Oregon oxalis, trailing blackberry, deer fern, red huckleberry, and Pacific trillium.

On the basis of a 100-year site curve, the mean site index is 145 for Douglas fir and 148 for western

hemlock. On the basis of a 50-year site curve, it is 114 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 152 cubic feet per acre per year, occurring at age 60. For western hemlock it is 234 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

272—Voight silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in residuum and colluvium derived dominantly from extrusive igneous rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,700 to 2,800 feet. The average annual precipitation is about 75 inches, and the average annual air temperature is about 43 degrees F. The average frost-free period is about 145 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and bark 10 inches thick. The surface layer is very dark grayish brown silt loam 11 inches thick. The upper 32 inches of the subsoil is brown silty clay loam. The lower 15 inches is reddish brown silty clay loam. The substratum to a depth of 60 inches is dark reddish brown and brown silt loam. In some areas the surface layer is silty clay loam, loam, or sandy loam. In other areas the soil has 15 to 35 percent weathered rock fragments in the subsoil and substratum or has 10 to 18 percent clay in the subsoil.

Included in this unit are small areas of Jonas, Pheeney, Scamman, and Zynbar soils and Voight soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Voight soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, vine maple, salal, Oregongrape, western brackenfern, Oregon oxalis, trailing blackberry, deer fern, red huckleberry, and Pacific trillium.

On the basis of a 100-year site curve, the mean site index is 145 for Douglas fir and 148 for western hemlock. On the basis of a 50-year site curve, it is 114 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 152 cubic feet per acre per year, occurring at age 60. For western hemlock it is 234 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. During an average year, snowpack limits the use of equipment and restricts access from January through March. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths,

properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects and a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

273—Welcome loam, 0 to 30 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in volcanic ash, colluvium, and slope alluvium derived dominantly from sandstone and modified by glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,500 feet. The average annual precipitation is about 80 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles and twigs 1 inch thick. When mixed to a depth of 5 inches, the surface layer is dark brown loam. The upper 7 inches of the subsoil is strong brown silt loam. The lower 23 inches is dark yellowish brown and light olive brown gravelly loam. The substratum is light olive brown fine sandy loam 18 inches thick. Weathered sandstone that crushes to loamy sand is at a depth of about 53 inches. The depth to weathered sandstone ranges from 40 to 60 inches. The content of soft rock fragments ranges from 15 to 35 percent. In some areas the surface layer is sandy loam or silt loam. In other areas the soil is 40 to 60 inches deep to dense glacial till or is more than 60 inches deep over bedrock.

Included in this unit are small areas of Elwell, Oakes, and Olomount soils and Welcome soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Welcome soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder and western redcedar. The common forest understory plants are red huckleberry, longtube twinflower, western swordfern, salal, and western brackenfern.

On the basis of a 100-year site curve, the mean site index is 135 for Douglas fir and is estimated to be 129 for western hemlock. On the basis of a 50-year site curve, it is 106 for Douglas fir and is estimated to be 89 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 139 cubic feet per acre per year, occurring at age 70. For western hemlock it is about 198 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

274—Welcome loam, 30 to 65 percent slopes. This deep, well drained soil is on mountain back slopes. It formed in volcanic ash, colluvium, and slope alluvium derived dominantly from sandstone and modified by glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,500 feet. The average

annual precipitation is about 80 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles and twigs 1 inch thick. When mixed to a depth of 5 inches, the surface layer is dark brown loam. The upper 7 inches of the subsoil is strong brown silt loam. The lower 23 inches is dark yellowish brown and light olive brown gravelly loam. The substratum is light olive brown fine sandy loam 18 inches thick. Weathered sandstone that crushes to loamy sand is at a depth of about 53 inches. The depth to weathered sandstone ranges from 40 to 60 inches. The content of soft rock fragments ranges from 15 to 35 percent. In some areas the surface layer is sandy loam or silt loam. In other areas the soil is 40 to 60 inches deep to dense glacial till or is more than 60 inches deep over bedrock.

Included in this unit are small areas of Elwell, Oakes, and Olomount soils and Welcome soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Welcome soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder and western redcedar. The common forest understory plants are red huckleberry, longtube twinflower, western swordfern, salal, and western brackenfern.

On the basis of a 100-year site curve, the mean site index is 135 for Douglas fir and is estimated to be 129 for western hemlock. On the basis of a 50-year site curve, it is 106 for Douglas fir and is estimated to be 89 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 139 cubic feet per acre per year, occurring at age 70. For western hemlock it is about 198 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer after logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. The rock available for road construction is poor-quality sandstone. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

275—Wilkeson gravelly silt loam, 6 to 15 percent slopes. This very deep, well drained soil is on foothills. It formed in residuum and colluvium derived dominantly from andesite and basalt. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 150 days.

When mixed to a depth of 8 inches, the surface layer is typically dark brown gravelly silt loam. The upper 8 inches of the subsoil is brown gravelly silt loam. The next 18 inches is dark yellowish brown gravelly loam and yellowish brown loam. The lower part to a depth of 60 inches is dark yellowish brown loam and yellowish brown gravelly loam. In some areas the surface layer is silt loam or loam. In other areas the soil has 27 to 35 percent clay in the subsoil.

Included in this unit are small areas of Mashel and Scamman soils and Wilkeson soils that have slopes of more than 15 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Wilkeson soil. Available water capacity is high. The effective rooting

depth is 60 inches or more. In most areas, runoff is slow and the hazard of water erosion is slight. In areas used as pasture, however, runoff is medium and the hazard of erosion is moderate.

This unit is used as woodland. It also is suitable as pasture and hayland.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, bigleaf maple, western redcedar, and bitter cherry. The common forest understory plants are western swordfern, vine maple, Oregongrape, red huckleberry, western brackenfern, Pacific trillium, trailing blackberry, bedstraw, salal, and violet.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

276—Wilkeson gravelly silt loam, 15 to 30 percent slopes. This very deep, well drained soil is on foothills. It formed in residuum and colluvium derived dominantly from andesite and basalt. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 150 days.

When mixed to a depth of 8 inches, the surface layer is typically dark brown gravelly silt loam. The upper 8 inches of the subsoil is brown gravelly silt loam. The next 18 inches is dark yellowish brown gravelly loam and yellowish brown loam. The lower part to a depth of 60 inches is dark yellowish brown loam and yellowish brown gravelly loam. In some areas the surface layer is silt loam or loam. In other areas the soil has 27 to 35 percent clay in the subsoil.

Included in this unit are small areas of Mashel and Scamman soils and Wilkeson soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Wilkeson soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, bigleaf maple, western redcedar, and bitter cherry. The common forest understory plants are western swordfern, vine maple, Oregongrape, red huckleberry, western brackenfern, Pacific trillium, trailing blackberry, bedstraw, salal, and violet.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of

compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

277—Wilkeson gravelly silt loam, 30 to 45 percent slopes. This very deep, well drained soil is on foothills. It formed in residuum and colluvium derived dominantly from andesite and basalt. The native vegetation is mainly conifers and shrubs. Elevation is 600 to 1,800 feet. The average annual precipitation is about 60 inches, and the average annual air temperature is about 47 degrees F. The average frost-free period is about 150 days.

When mixed to a depth of 8 inches, the surface layer is typically dark brown gravelly silt loam. The upper 8 inches of the subsoil is brown gravelly silt loam. The next 18 inches is dark yellowish brown gravelly loam and yellowish brown loam. The lower part to a depth of 60 inches is dark yellowish brown loam and yellowish brown gravelly loam. In some areas the surface layer is silt loam or loam. In other areas the soil has 27 to 35 percent clay in the subsoil.

Included in this unit are small areas of Mashel and Scamman soils and Wilkeson soils that have slopes of more than 45 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Wilkeson soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, bigleaf maple, western redcedar, and bitter cherry. The common forest understory plants are western swordfern, vine maple, Oregongrape, red huckleberry, western brackenfern, Pacific trillium, trailing blackberry, bedstraw, salal, and violet.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 161. On the basis of a 50-year site curve, it is 122. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Unmanaged fires in undisturbed areas result in a moderate reduction in productivity on north aspects a severe reduction on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIe.

278—Winston loam, 0 to 8 percent slopes. This very deep, well drained soil is on outwash terraces. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,500 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 11 inches, the surface layer is dark brown loam. The upper 10 inches of the subsoil is dark brown gravelly loam. The lower 13 inches is dark brown gravelly fine sandy loam. The substratum to a depth of 60 inches is very dark grayish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 14 to 38 inches. In some areas the surface layer is silt

loam or gravelly loam. In other areas the substratum is very gravelly sandy loam or has 15 to 35 percent rock fragments.

Included in this unit are small areas of Barneston, Blethen, and Sulsavar soils, soils that are less than 14 inches deep to extremely gravelly sand, Shalcar soils in depressions, and Winston soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Winston soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture.

In the areas used for hay and pasture, the main limitations are compaction and the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. In summer, irrigation is required for maximum production.

Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are salal, Oregongrape, western brackenfern, western swordfern, vine maple, red huckleberry, trailing blackberry, evergreen blackberry, rose, salmonberry, devilsclub, and violet.

On the basis of a 100-year site curve, the mean site index is 164 for Douglas fir and 162 for western hemlock. On the basis of a 50-year site curve, it is 125 for Douglas fir and 114 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 174 cubic feet per acre per year, occurring at age 60. For western hemlock it is 258 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IIIe.

279—Winston loam, 8 to 30 percent slopes. This very deep, well drained soil is on outwash terraces and escarpments. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,500 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 11 inches, the surface layer is dark brown loam. The upper 10 inches of the subsoil is dark brown gravelly loam. The lower 13 inches is dark brown gravelly fine sandy loam. The substratum to a depth of 60 inches is very dark grayish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 14 to 38 inches. In some areas the surface layer is silt loam or gravelly loam. In other areas the substratum is very gravelly sandy loam or has 15 to 35 percent rock fragments.

Included in this unit are small areas of Barneston, Blethen, and Sulsavar soils, soils that are less than 14 inches deep to extremely gravelly sand, Shalcar soils in depressions, and Winston soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Winston soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are salal, Oregongrape, western brackenfern, western swordfern, vine maple, red huckleberry, trailing blackberry, evergreen blackberry, rose, salmonberry, devilsclub, and violet.

On the basis of a 100-year site curve, the mean site

index is 164 for Douglas fir and 162 for western hemlock. On the basis of a 50-year site curve, it is 125 for Douglas fir and 114 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 174 cubic feet per acre per year, occurring at age 60. For western hemlock it is 258 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

280—Winston loam, windswept, 0 to 30 percent slopes. This very deep, well drained soil is on outwash terraces and escarpments. It formed in volcanic ash and glacial outwash. The native vegetation is mainly confers and shrubs. Elevation is 1,000 to 1,500 feet. The average annual precipitation is about 55 inches, and the average annual air temperature is about 48 degrees F. The average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 11 inches, the surface layer is dark brown loam. The upper 10 inches of the subsoil is dark brown gravelly loam. The lower 13 inches is dark brown gravelly fine sandy loam. The substratum to a depth of 60 inches is very dark grayish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 14 to 38 inches. In some areas the surface layer is silt loam or gravelly loam. In other areas the substratum is very gravelly sandy loam or has 15 to 35 percent rock fragments.

Included in this unit are small areas of Barneston, Blethen, and Sulsavar soils, soils that are less than 14 inches deep to extremely gravelly sand, Shalcar soils in depressions, and Winston soils that have slopes of more than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Winston soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. The common forest understory plants are salal, Oregongrape, western brackenfern, western swordfern, vine maple, red huckleberry, trailing blackberry, evergreen blackberry, rose, salmonberry, devilsclub, and violet.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 117. On the basis of a 50-year site curve, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 110 cubic feet per acre per year, occurring at age 60. Estimates of the site index and growth rate of western hemlock have not been made. The trees are desiccated in winter by winds blowing west from the Cascade Mountains.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and

growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

281—Woodinville silt loam, 0 to 2 percent slopes. This very deep, poorly drained soil is on flood plains. It formed in alluvium stratified with decomposed organic material. The native vegetation is mainly trees and shrubs. Elevation is 50 to 120 feet. The average annual precipitation is about 45 inches, and the average annual air temperature is about 50 degrees F. The average frost-free period is about 190 days.

Typically, the surface layer is dark brown silt loam 7 inches thick. The upper 5 inches of the underlying material is light olive gray silt loam. The next 3 inches is olive gray silt loam. The lower part to a depth of 60 inches is dark brown and grayish brown, stratified silt loam and sapric material. In some areas the surface layer is silty clay loam. In other areas the soil has a dark brown surface layer. In places the substratum does not have sapric material, has 10 to 18 percent clay, or has thin strata of sand.

Included in this unit are small areas of undrained Woodinville soils, Shalcar soils in depressions that are subject to ponding, and small bodies of water. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Woodinville soil. Available water capacity is high. The effective rooting depth is limited by an apparent high water table, which is at a depth of 1.5 to 3.0 feet from October through April. Runoff generally is very slow, but can be ponded during the winter months. There is no hazard of erosion. This soil is subject to rare flooding.

This unit is used mainly for hay and pasture. The included undrained Woodinville soils are used as woodland.

In the areas used for hay and pasture, the main limitations are the high water table, the hazard of flooding, and the moderately slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In undrained areas and in areas where the drainage system is not maintained, the water table limits the choice of forage species to grasses and shallow-rooted legumes. The wetness in these areas limits the period of cutting or grazing and increases the risk of winterkill.

The main limitations affecting cropland are the high water table, the hazard of flooding, and the moderately slow permeability. This soil is well suited to most of the crops commonly grown in the survey area if adequate drainage systems are maintained. The principal crops are corn silage and small grain. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth. During the growing season, the water table is lowered by tile drains and field ditches to a depth of about 3 to 5 feet. Measures that maintain the drainage system are needed to ensure adequate production. Maintaining the drainage system permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar and black cottonwood. The common forest understory plants are spirea, rose, vine maple, and sedges.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This unit is in capability subclass IIw.

282—Zynbar loam, 6 to 30 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, colluvium derived from igneous rocks, and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 2 inches thick. When mixed to a depth of 18 inches, the surface layer is dark brown loam. The subsoil is dark yellowish brown gravelly silt loam 23 inches thick. The substratum to a depth of 60 inches is dark yellowish brown silt loam. In some areas the surface layer is silt loam. In other areas the soil has strata of sandy material in the subsoil, has 35 to 50 percent rock fragments in the substratum, or is underlain by dense glacial till at a depth of 40 to 60 inches.

Included in this unit are small areas of Jonas and Pitcher soils and Zynbar soils that have slopes of more than 30 percent or less than 6 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Zynbar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are Oregongrape, western brackenfern, western swordfern, vine maple, red huckleberry, trailing blackberry, common beargrass, Oregon oxalis, Pacific trillium, violet, devilsclub, bedstraw, and salal.

On the basis of a 100-year site curve, the mean site index is 161 for Douglas fir and 157 for western hemlock. On the basis of a 50-year site curve, it is 123 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65. For western hemlock it is 249 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

283—Zynbar loam, 30 to 65 percent slopes. This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, colluvium derived from igneous rocks, and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,800 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 2 inches thick. When mixed to a depth of 18 inches, the surface layer is dark brown loam. The subsoil is dark yellowish brown gravelly silt loam 23 inches thick. The substratum to a depth of 60 inches is dark yellowish brown silt loam. In some areas the surface layer is silt loam. In other areas the soil has strata of sandy material in the subsoil, has 35 to 50 percent rock fragments in the substratum, or is underlain by dense glacial till at a depth of 40 to 60 inches.

Included in this unit are small areas of Jonas and Pitcher soils and Zynbar soils that have slopes of more than 65 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Zynbar soil. Available water capacity is high. The effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir and

western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are Oregongrape, western brackenfern, western swordfern, vine maple, red huckleberry, trailing blackberry, common beargrass, Oregon oxalis, Pacific trillium, violet, devilsclub, bedstraw, and salal.

On the basis of a 100-year site curve, the mean site index is 161 for Douglas fir and 157 for western hemlock. On the basis of a 50-year site curve, it is 123 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65. For western hemlock it is 249 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. They generally are used on this unit. During an average year, snowpack limits the use of equipment and restricts access from January through March. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, or using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling and the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas on south aspects.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass VIIe.

284—Zynbar silt loam, till substratum, 0 to 15 percent slopes. This very deep, moderately well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash and andesitic colluvium over glacial drift. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,300 feet. The average annual precipitation is about 85 inches, and the average annual air temperature is about 44 degrees F. The average frost-free period is about 150 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 2 inches thick. The surface layer is dark brown silt loam 9 inches thick. The upper 20 inches of the subsoil also is dark brown silt loam. The lower part to a depth of 60 inches or more is yellowish brown very gravelly silt loam. In some areas the surface layer is loam or gravelly silt loam. In other areas the soil has strata of sandy material in the subsoil, has 35 to 50 percent rock fragments in the substratum, or is 20 to 40 inches deep to dense glacial till.

Included in this unit are small areas of Jonas and Pitcher soils and Zynbar soils that have slopes of more than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Zynbar soil. Available water capacity is high. The effective rooting depth is limited by a perched high water table, which is at a depth of 3 or 4 feet from December through March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common forest understory plants are western swordfern, red huckleberry, salal, western brackenfern, Oregon oxalis, salmonberry, devilsclub, longtube twinflower, Oregongrape, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index is 161 for Douglas fir and 157 for western hemlock. On the basis of a 50-year site curve, it is 123 for Douglas fir and 110 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65. For western hemlock it is 249 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground

equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of soil compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is in capability subclass IVe.

Prime Farmland

Prime farmland is of major importance in meeting the Nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to food, seed, forage, fiber, and oilseed crops. Such soils have properties that favor the economic production of sustained high yields of crops. The soils need only to be treated and managed by acceptable farming methods. An adequate moisture supply and a sufficiently long growing season are required. Prime farmland soils produce the highest yields with minimal expenditure of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils either are used for food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils commonly receive an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and length of growing season are favorable, and the level of acidity or alkalinity is acceptable. The soils have few, if any, rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent.

Some soils that have a seasonal high water table qualify as prime farmland soils only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

A recent trend in land use has been the conversion of prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on lands that are less productive than prime farmland.

About 51,170 acres, or more than 4 percent of the survey area, meets the requirements for prime farmland or would meet the requirements if adequate drainage systems were installed. The map units in the survey area that are considered prime farmland or meet the requirements for prime farmland where they are drained are listed in table 5. The location of each map unit is shown on the detailed soil maps at the back of this publication. Soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

In this section, the system of land capability classification used by the Soil Conservation Service is explained. Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information, such as yield data, can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Most of the survey area is forested. The slopes are steeper and the growing season is shorter in the forested areas than in the lowlands. Most of the prime farmland in the survey area that is not forested is pasture. Agricultural crops are not grown in the survey area. If a drainage system were installed, they could be grown in areas where the growing season is long enough for the crops to mature.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(30)*. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the

choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Woodland Management and Productivity

By William J. Westberg, consulting forester, Washington State Department of Natural Resources.

This section provides a description of the forest zones within the survey area and of the environmental variables that influence forest productivity, an overview of forest management considerations, and an explanation of woodland suitability symbols and of site indexes, which are values used for quantifying potential forest productivity.

About 90 percent of the survey area supports trees in various stages of growth. The forest land is used mainly for the production of timber. It also is used for watershed, for wildlife habitat, and as a site for recreational activities. Other areas include high mountain meadows, pastures, towns and villages, industrial sites, and highway and railroad right-of-ways.

Forest Ecology and Productivity

The survey area has three distinct forest zones characterized by unique plant communities. The first is the western hemlock zone, which ranges in elevation from sea level to about 2,700 feet above sea level. It is in river valleys and on glacial drift plains and foothills. The second is the Pacific silver fir zone, which ranges in elevation from about 1,700 to 4,200 feet. It is on mountains and high mountains. The third is the mountain hemlock zone. It ranges in elevation from 4,200 feet to the timberline, which is at about 5,500 feet. It is on high mountains. The exact elevation at which adjacent zones merge into each other varies, depending on local environmental conditions.

The *western hemlock zone* is the largest of the three zones. It is the most important zone for the production of timber. It has a wet, mild, maritime climate. The mean annual precipitation ranges from about 50 inches at the base of the Cascade Mountains to about 110 inches at the transition to the Pacific silver fir zone. Summers are relatively dry, receiving less than 10 percent of the total annual rainfall. The mean annual temperature is about 47 degrees F.

This zone supports extensive second-growth stands of Douglas fir and some remnant, old-growth stands of mixed western hemlock and Douglas fir. The name of the zone is derived from the predominance of western hemlock in the oldest stands. Douglas fir and western redcedar are important coniferous species in this zone. Sitka spruce grows in some areas along watercourses. Pacific silver fir grows at the highest elevations in the zone. In unmanaged stands the proportion of western hemlock to Douglas fir increases with increasing elevation.

Deciduous trees are common on disturbed sites, primarily logged or burned areas. They also are common along watercourses, in poorly drained areas, and in excessively drained areas. Red alder, bigleaf maple, and black cottonwood are the most common species, especially in low, moist areas. Bigleaf maple also is common on dry, south- and west-facing escarpments. Madrona grows in the driest areas.

Typically, the understory shrubs in this zone are Oregongrape, salal, red huckleberry, vine maple, and Pacific yew. The common herbaceous plants are western swordfern, northern twinflower, trillium, deer fern, evergreen violet, and Oregon oxalis.

Talus slopes are common throughout the survey area. They are dominated by vine maple and shrubs, such as creambush oceanspray, creeping snowberry,

and California hazel. Typically, the herbaceous plants on these dry sites are common beargrass, parsley fern, and lace fern.

The *Pacific silver fir zone* is wetter and cooler than the western hemlock zone and receives more snowfall. The mean annual precipitation is about 110 inches, much of which accumulates as winter snowpack. The snowpack reaches a depth of about 10 feet. The mean annual temperature is about 42 degrees F.

This zone is dominated by Pacific silver fir. Other common species are western hemlock, noble fir, western redcedar, and Douglas fir and a few mountain hemlock and Alaska cedar. Deciduous trees are not common. Western hemlock, which is most common at the lower elevations, is typically displaced by mountain hemlock and Alaska cedar near the upper limits of the zone. Western redcedar and Douglas fir are most common near the transition to the western hemlock zone.

Typically, the understory shrubs are vine maple, Oregongrape, salal, red huckleberry, tall blue huckleberry, and Alaska huckleberry. The common herbaceous plants are common beargrass, northern twinflower, bunchberry dogwood, queencup beadlily, and vanillaleaf.

Sitka alder grows to a height of 15 feet on some avalanche chutes. Alaska cedar grows in scattered areas adjacent to some of the avalanche chutes.

The *mountain hemlock zone* is the wettest and coolest of the three forest zones. It is the smallest zone and the least important for the production of timber. The mean annual precipitation is about 130 inches. The winter snowpack can reach a depth of 25 feet. The mean annual temperature is about 39 degrees F.

Alaska cedar and Pacific silver fir are associated with mountain hemlock throughout the zone. Mountain hemlock, however, generally dominates the oldest stands. Typically, the understory scrubs and herbaceous plants are similar to those in the lower adjacent zone.

Forest productivity ranges from high on the rolling uplands of the western hemlock zone to very low on the high ridge crests of the Pacific silver fir zone and the mountain hemlock zone. It varies within each zone, depending on a combination of environmental factors that affect tree growth.

Factors that influence productivity include elevation, content of rock fragments in the soil, the content and depth of organic matter, the position and aspect of slopes, exposure to persistent wind, and the amount of clay and volcanic ash in the soil. Generally, productivity decreases as elevation and the content of rock fragments increase and as the depth to bedrock decreases. Soils that are less than 18 inches deep over bedrock are unable to support sustained growth. Productivity increases as the content and depth of incorporated organic matter increase. It tends to be lower on ridge crests and the upper slopes and higher on foot slopes. South- and west-facing slopes are less productive than north- and east-facing slopes. Productivity is decreased in some areas by persistent wind, depending on the force, constancy, and moisture content of the wind. Persistent wind has the greatest effect when the ground is frozen. A moderate amount of clay or fine volcanic ash in the soil can increase productivity.

Management Considerations

Stand establishment is the primary concern affecting the production of timber in the survey area. The most common method of establishment is planting coniferous seedlings. Natural regeneration, however, occurs where the stands include seed trees. It commonly results in the establishment of mixed stands. The proportion of undesirable species varies in naturally regenerated stands, and the growth of red alder can be a significant problem at the lower elevations.

Droughtiness in the surface layer, which is caused by a low amount of rainfall and high temperatures during the growing season, reduces the seedling survival rate. It is especially critical in sandy soils and in soils that have a high content of rock fragments or of coarse volcanic ash and cinders near the surface. The seedling survival rate also is reduced by fires or harvesting methods that remove the protective layer of organic material and by persistent winds, which dry the soil. Persistent winds are common on exposed ridge crests, on side slopes and constrictions in wide valleys, and on alluvial fans at the head of some of the major drainageways.

Typically, the plant nutrients in soils that formed in glacial outwash or at high elevations are concentrated in dark layers near the surface. If these layers are destroyed by intensive burning or by careless harvesting methods, fertility can be seriously reduced.

When wet, soils that have fine textured or medium textured surface layers are subject to compaction and rutting. Compaction reduces the seedling survival rate and the growth rate of the more mature trees by restricting permeability and root development. Rutting may expose tree roots to damage by ground equipment.

A high water table during the growing season restricts the depth of the root zone, reducing productivity. Shallow-rooted trees are subject to windthrow. The use of wheeled or tracked vehicles is restricted during wet periods. Saturated soils can be invaded by undesirable deciduous species.

The main limitation affecting timber harvesting is the

slope. The use of ground equipment on soils that have slopes of more than 30 percent generally is impractical and dangerous. Cable systems are safer and disturb the surface less extensively.

In steep areas road construction is influenced more by the underlying material than by the soil. Soil characteristics are important in gently sloping areas and in poorly drained areas. Glacial outwash, alluvium, and unweathered bedrock provide a stable base for roads. These construction materials generally can be easily located. Roads built in steep areas underlain by breccia, phyllite, or sandstone or through thick deposits of volcanic ash and cinders are subject to mass movement. Sidecast material may slough when saturated. Roads on gently sloping soils that have a fine or medium texture require suitable surfacing for year-round use. Roads in poorly drained areas require a thicker base and extra culverts. Raveling of the soil material can occur along roads constructed with steep cuts through areas of dry outwash.

Generally, the hazard of erosion is minor in forested areas. Rill and gully erosion may occur where harvesting has destroyed the protective surface layer. Steep, unsurfaced logging roads, unvegetated skid trails, and firebreaks also are subject to erosion.

The success of many woodland management practices can be predicted through knowledge of the properties of the various soils. Detailed descriptions of the soils in the survey area are in the section "Detailed Soil Map Units." The description of each map unit that is suitable for woodland provides information concerning potential productivity, the limitations affecting timber production and harvesting, and common tree species and forest understory plants.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for woodland. Only the soils suitable for woodland are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils that are assigned the same ordination symbol require the same general management and have about the same potential productivity.

The *ordination symbol* is based on a uniform system of labeling an individual soil to determine the productivity potential and the principal soil properties in relation to any hazards or limitations of that soil. The first element of the ordination symbol is a number that denotes potential productivity in terms of cubic meters of wood per hectare per year for the indicator tree species. Potential productivity is based on site index and the corresponding culmination of mean annual increment. For example, the number 1 indicates a potential production of 1 cubic meter of wood per hectare per year (14.3 cubic feet per acre per year) and 10 indicates a potential production of 10 cubic meters of wood per hectare per year (143 cubic feet per acre per year). Cubic feet multiplied by five equals the approximate volume of growth in Scribner board feet.

The second element of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *D*, restricted rooting depth; *S*, sandy texture; *F*, a high content of rock fragments in the soil, and *N*, a restriction caused by the depth or duration of the snowpack. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, D, S, F, and N.

In table 7, *slight, moderate,* and *severe*, indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, wetness, snowpack, and texture of the surface layer. A rating of *slight* indicates that the use of equipment is not normally restricted to a particular kind of equipment or time of year. Soil wetness can restrict the use of equipment, but the wet period does not exceed 2 months. A rating of *moderate* indicates that the use of equipment is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts the use of equipment for a period of 2 to 6 months. A rating of *severe* indicates that either the kind of equipment that can be used or the time of year it can be used is severely restricted. If the soil is wet, the wetness restricts the use of equipment for more than 6 months.

Operating wheeled equipment becomes more difficult as the gradient and length of slopes increase. The degree of difficulty generally increases on slopes of 25 to 35 percent. On steeper slopes, generally those of 35 to 45 percent, tracked equipment should be used. On the steepest slopes, even tracked equipment cannot be operated safely and more sophisticated systems should be used. Wetness, especially in combination with a fine texture, can severely limit the use of equipment, making harvesting practical only during dry summer months.

Seedling mortality refers to the of death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, wetness, climate, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, climate, and aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown over by the wind. Strong winds may damage the trees but do not uproot them. A rating of *moderate* indicates that some trees can be blown over during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown over during these periods.

Ratings of *plant competition* indicate the degree to which undesirable species are expected to invade and grow when openings are made in the tree canopy. The main factors that affect plant competition are depth to the water table, climate, and available water capacity. A rating of *slight* indicates that competition from undesirable plants is not likely to prevent natural regeneration or suppress the more desirable species. Planted seedlings can become established without undue competition. A rating of *moderate* indicates that competition may delay the establishment of desirable species. Competition may hamper stand development, but it will not prevent the eventual development of fully stocked stands. A rating of *severe* indicates that competition can be expected to prevent regeneration unless precautionary measures are applied.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a site index and a productivity class. The *site index* is the average height, in feet, that dominant and codominant trees of a given species attain in 50 years. It applies to fully stocked, even-aged, unmanaged stands. The site index for a specific soil is derived from onsite measurements of the dominant and codominant trees of a specific species. Research literature is used to calculate the average site index for a given species *(3, 20, 22, 33, 34)*. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Generally, map units with a higher site index can be expected to produce more wood fiber than those with a lower site index. A site index for a species on one map unit should be compared only to site indexes for the same species on other map units. A site index was not assigned to any minor species. Because of a lack of data or a suitable site index publication, it also was not assigned to certain principal species.

The *productivity class* represents the yield likely to be produced by the most important trees. It is expressed in cubic meters per hectare per year. It indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

The species assigned the highest productivity symbol under *common trees* is the indicator species for that soil. It can be the dominant species on the soil and is the one that generally determines the ordination class.

Trees to plant are those that are suitable and preferred for commercial wood production *(7, 8, 9, 10, 11)*.

Recreation

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design,

intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

This survey area has a variety of habitats that support many species of wildlife. Habitats range from the open areas along the western boundary of the survey area to the alpine areas of the Cascades. Elevations range from 400 feet to more than 6,000 feet above sea level.

The soils on the lowlands, flood plains, and bottom land and in some warm areas in the uplands provide habitat for openland wildlife, such as pheasants, California quail, and rabbits. Other warm areas in the uplands support extensive stands of second-growth Douglas fir and red alder. Associated species include western hemlock, western redcedar, bigleaf maple, grand fir, and bitter cherry. These wooded areas have a diverse understory vegetation that includes salal, cascade Oregongrape, western brackenfern, western swordfern, vine maple, red huckleberry, trailing blackberry, Pacific trillium, northern twinflower, violet, bedstraw, Oregon oxalis, thimbleberry, and rose. The woodland provides habitat for ruffed grouse, woodpeckers, chipmunks, squirrels, mountain beaver, coyote, black-tailed deer, and elk.

At the higher elevations, in the cool mountainous areas of the Cascades, the soils support western hemlock and Douglas fir. Associated species include Pacific silver fir, western redcedar, and red alder. The understory includes western brackenfern, red huckleberry, western swordfern, salal, deer fern, and Oregon oxalis. The wildlife in these areas include species typical of the warmer areas and black bear, bobcat, and cougar.

In the cold areas in the Cascades, the soils support stands of western hemlock, Pacific silver fir, old-growth Douglas fir, and relatively young Douglas fir. Associated species include western redcedar, noble fir, western white pine, mountain hemlock, Alaska cedar, and black cottonwood. Sitka alder and willows grow in some wet spots, seep areas, and avalanche tracks. The understory includes cascade Oregongrape, bunchberry dogwood, common beargrass, princes pine, tall blue huckleberry, and western swordfern. The wildlife in these areas include many of the species typical of warmer areas. These colder areas also provide seasonal food and cover for migrating deer and elk.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management,

and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are sedges, wild strawberry, and heartleaf arnica.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are red alder, cottonwood, poplar, cherry, apple, hawthorn, and dogwood.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are Douglas fir, hemlock, and Pacific silver fir.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are huckleberry, salal, and ceanothus.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are cattail, smartweed, wild millet, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include pheasant, meadowlark, quail, and rabbits.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, thrushes, woodpeckers, squirrels, deer, and bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and

construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreation uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the "Glossary."

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features generally are favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills generally are limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of

the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40

inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are

affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, a low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features listed in tables are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*. Both systems are described in the "PCA Soil Primer" *(24)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 10 inches and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3

inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. No value is given for soils that formed in material having a high content of volcanic ash. The textures specified for these soils are apparent field textures. Because of the influence of the ash, a complete clay dispersion is not obtained in the laboratory and the reported clay values are low. The measured physical and chemical properties for these soils indicate a much higher content of clay than is reported by the laboratories.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Tables 16 and 17 give estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a

saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Cemented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 17 shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.