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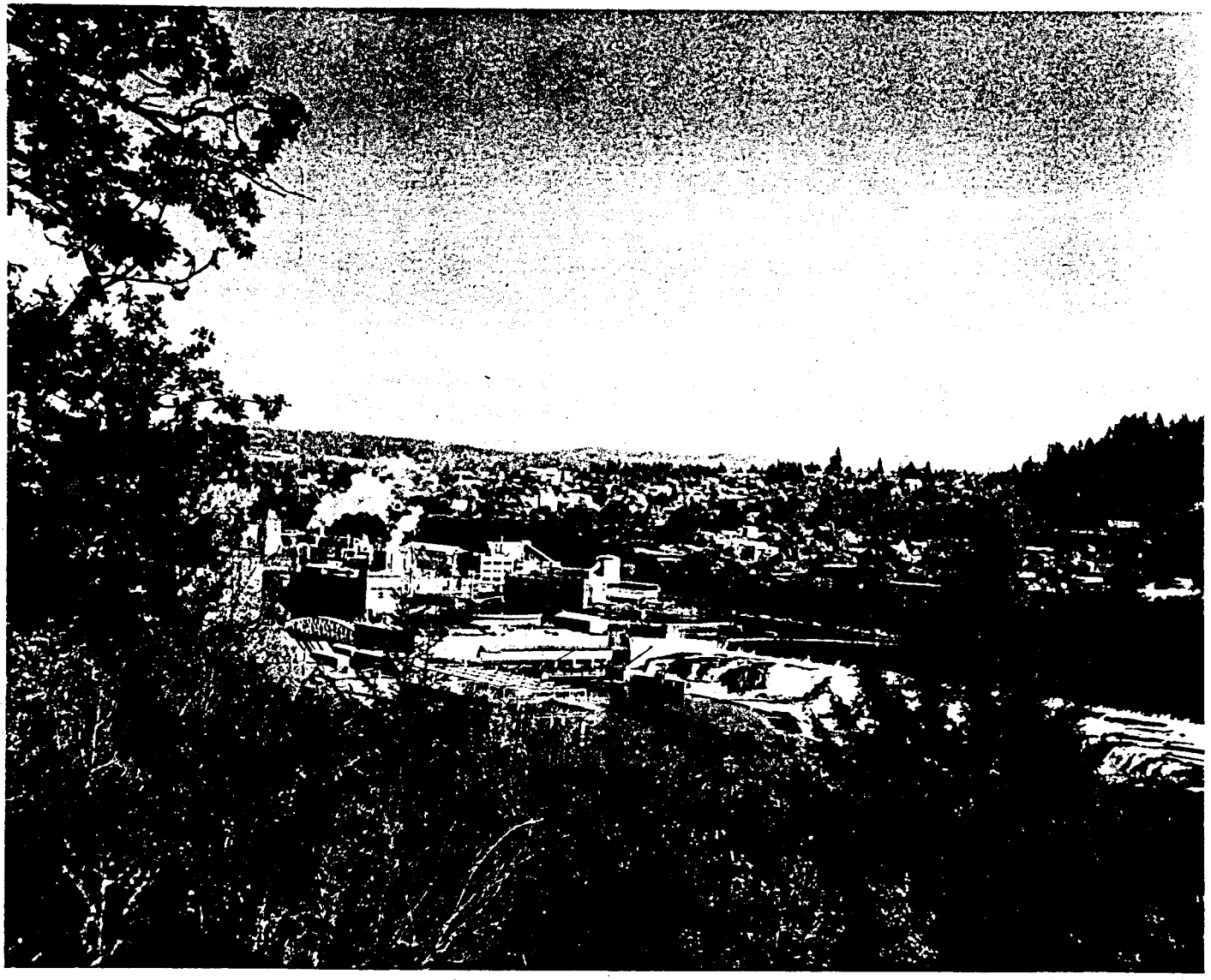
United States Department of Agriculture

Soil Conservation Service

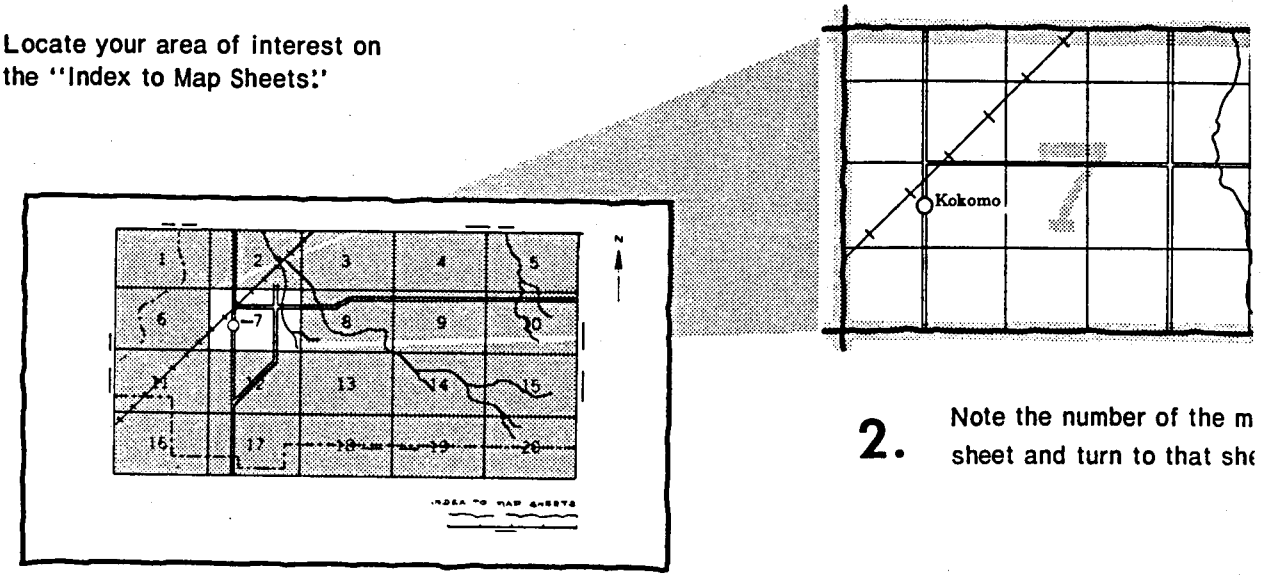
In cooperation with United States Department of the Interior, Bureau of Land Management, and Oregon Agricultural Experiment Station

Soil Survey of Clackamas County Area, Oregon



HOW TO U

1. Locate your area of interest on the "Index to Map Sheets."



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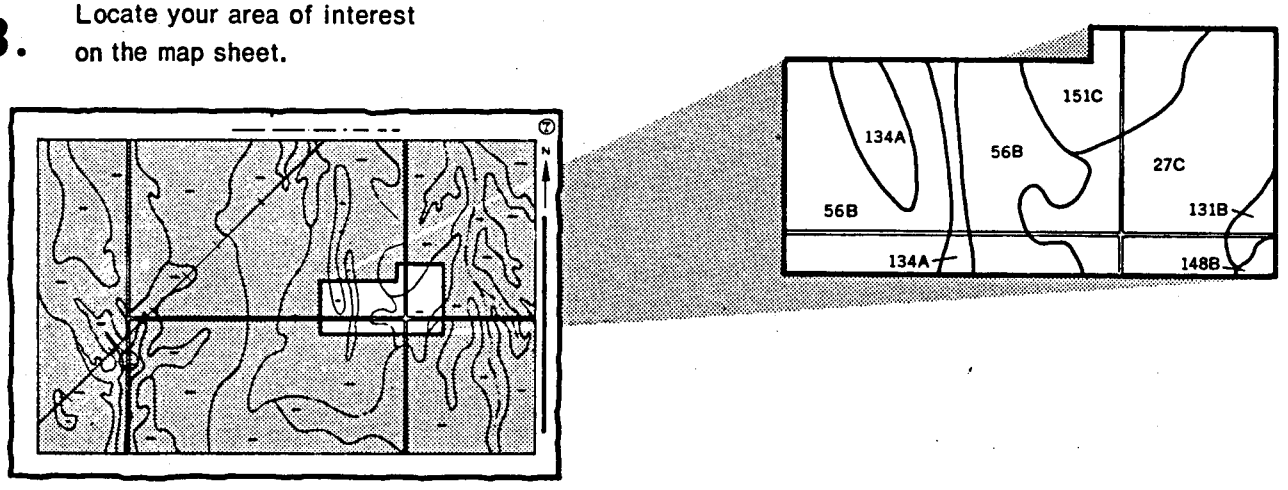
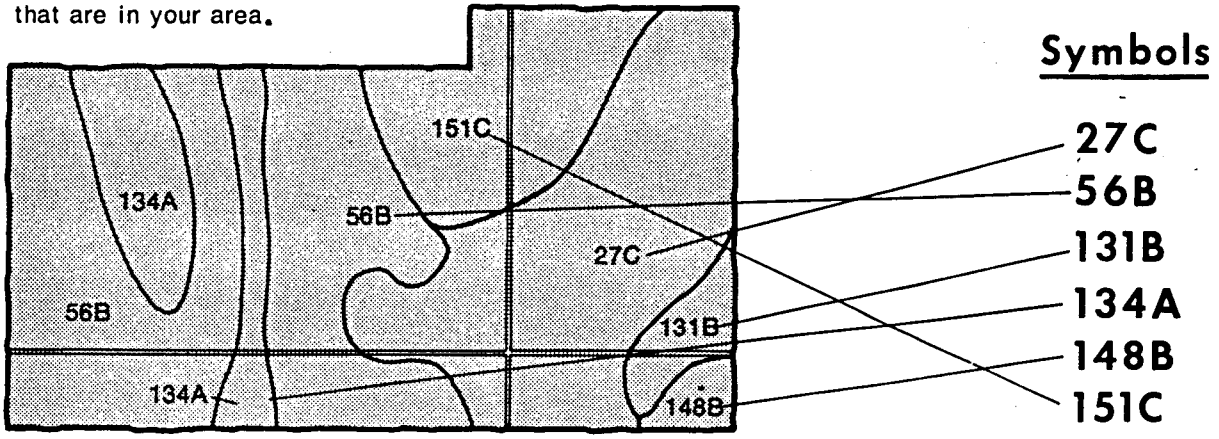
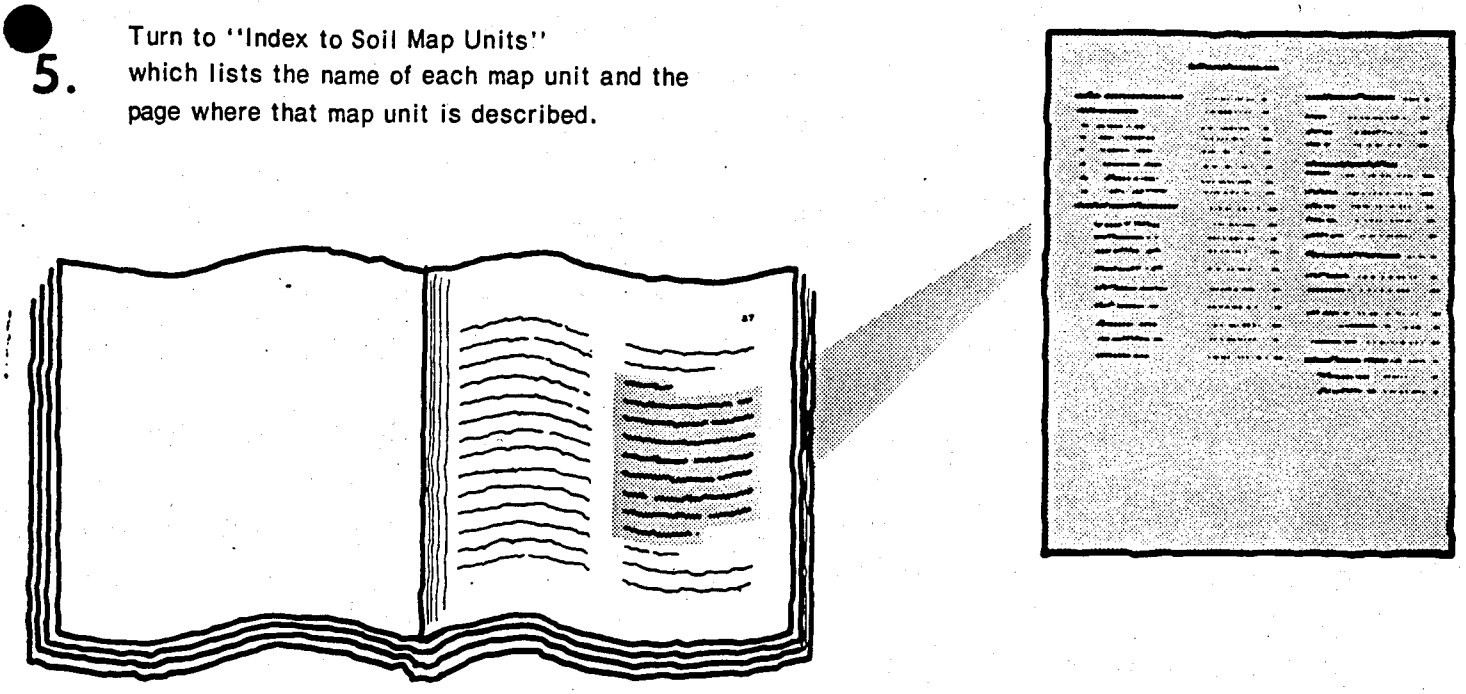


4. List the map unit symbols that are in your area.

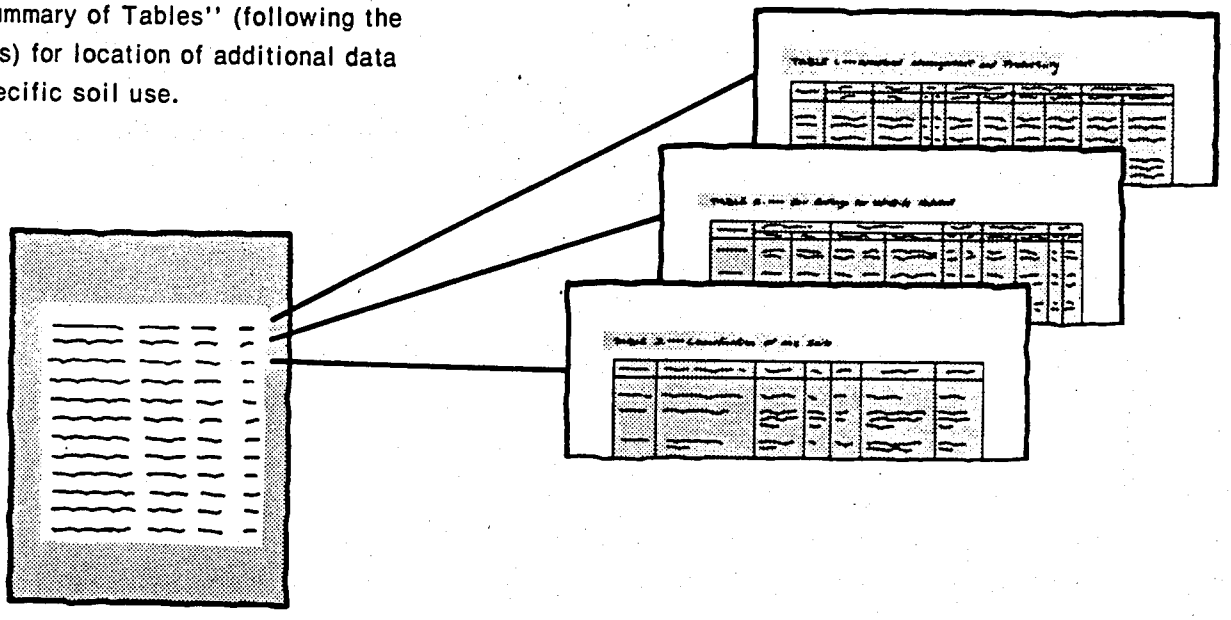


HIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

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. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1981. Soil names and descriptions were approved in 1982. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982. This survey was made cooperatively by the Soil Conservation Service, the Bureau of Land Management, and the Oregon Agricultural Experiment Station. It is part of the technical assistance furnished to the Clackamas Soil and Water Conservation District.

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.

Cover: Paper mill at Willamette Falls in Oregon City. Trees in foreground on Witzel soils. Saum soils and Xerochrepts across the Willamette River, and Mount Hood in background.

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Soil Series

Issued November 1985

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Summary of Tables

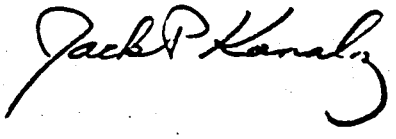
Foreword

This soil survey contains information that can be used in land-planning programs in Clackamas County Area, Oregon. 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.

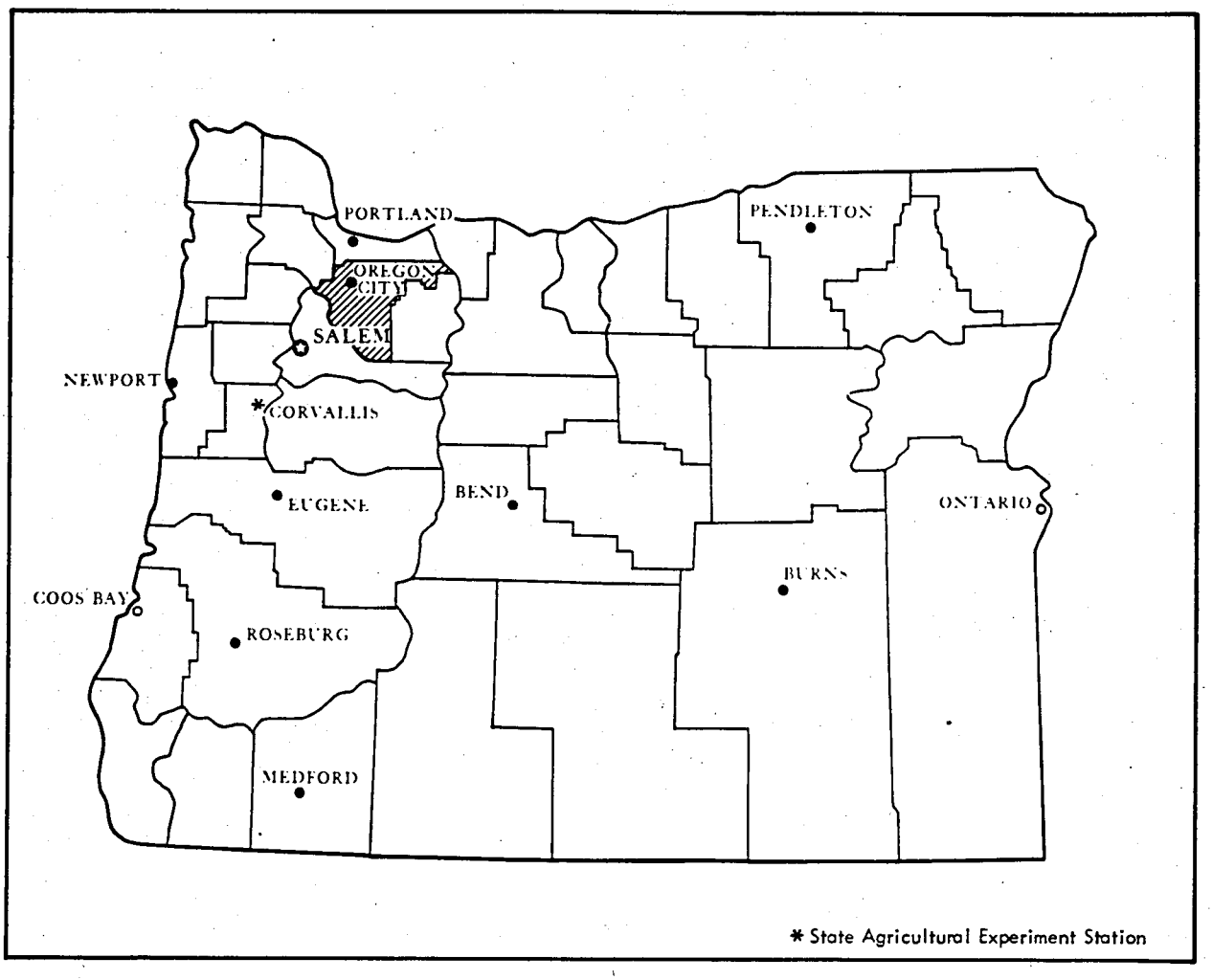
This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure 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.



Jack P. Kanalz
State Conservationist
Soil Conservation Service



Location of Clackamas County Area in Oregon.

Soil Survey of Clackamas County Area, Oregon

By Allen J. Gerig, Soil Conservation Service

Fieldwork by Richard T. Smythe, Richard F. Howard, Duane K. Setness, Randy E. McAllister, Bill Child, Karen L. Strohmeyer, and Allen J. Gerig, Soil Conservation Service, and
David L. Green and Bruce Ahrendt, Bureau of Land Management

United States Department of Agriculture, Soil Conservation Service
In cooperation with
United States Department of the Interior, Bureau of Land Management, and
Oregon Agricultural Experiment Station

CLACKAMAS COUNTY AREA is in the northwestern part of Oregon. It consists of that part of Clackamas County that is outside the boundary of the national forest, which is about the western half of the county. It has an area of about 641,600 acres, or 1,003 square miles. In 1980 the population of the area was about 242,000, most of which was in the northwestern part of the area.

The survey area is at the northern end of the Willamette Valley. It extends east from Parrett Mountain, west of Wilsonville, to the western slope of the Cascade Range. Most of the survey area is drained by the northerly flowing Willamette River and its major tributaries from the east, including Butte Creek, the Molalla River, and the Clackamas River. The Sandy River, in the northeastern part of the area, flows directly into the Columbia River.

The southwestern part of the area is a broad, nearly level, low terrace that is drained by many small streams. The northern part of the area is gently sloping uplands that are deeply dissected by several streams and rivers. The eastern part of the area consists of the moderately steep to very steep foot slopes of the Cascade Range. Elevation ranges from about 50 feet in the northwestern corner of the area to about 5,000 feet in the southeastern corner.

Farming is the main enterprise in the southwestern part of the area. The major crops are wheat, corn, beans, and hay. Timber production and livestock are the main enterprises in the central part of the area. The northwestern part of the area is used for industry and urban development (fig. 1). The northern part is used mainly for specialty crops. Timber production is the main enterprise in the eastern part of the area (fig. 2).

The soils in the area range widely in texture, drainage, and other characteristics. The soils in the southwestern part are dominantly silt loam and silty clay loam. Most of these soils are somewhat poorly drained to well drained. Tile drainage systems have been installed in many areas of the soils that are less than well drained, which makes them well suited to most crops.

The soils in the northern part of the area are mainly silty, and many of them have a brittle hardpan in the subsoil (*33*). The hardpan perches water at a depth of 6 to 40 inches.

The soils in the eastern part of the area are dominantly well drained loam and gravelly loam, and they have a high content of volcanic ash. Slopes are moderately steep to very steep, and annual precipitation ranges from 60 to 100 inches or more.

An older soil survey of Clackamas County was published in 1926 (*23*). The present survey updates the earlier survey and provides additional information and larger maps that show the soils in greater detail.

Descriptions, names, and delineations of soils in this soil survey do not coincide completely with those of soil maps for adjacent counties. Differences are the result of advances in knowledge of soils, modifications in series concepts, and changes in intensity of mapping.

Climate

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

The climate of the survey 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 not common except at the higher elevations. Rainfall is extremely light during summer, so crops growing actively during this period need irrigation. Often, several weeks pass without precipitation. Rains are frequent during the rest of the year, especially late in fall and in winter.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Estacada, Government Camp, and North Willamette during the periods 1951-73, 1951-76, and 1963-77, respectively. 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 temperature is 41 degrees F at Estacada, 31 at Government Camp, and 41 at North Willamette and the average daily minimum temperature is 35 degrees at Estacada, 25 at Government Camp, and 34 at North Willamette. The lowest temperature on record, which occurred at Government Camp on December 17, 1964, is -14 degrees. In summer, the average temperature is 64 degrees at Estacada, 54 at Government Camp, and 64 at North Willamette and the average daily maximum temperature is 73 degrees. The highest recorded temperature, which occurred at Estacada on July 8, 1952, is 107 degrees.

Figure 1.—Urban development in an area of Witzel soils.

Figure 2.—Timber on Kinzel and Divers soils. Highcamp and Soosap soils are on Goat Mountain in background.

Growing degree days are shown in table 1. They 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 61 inches at Estacada, 90 inches at Government Camp, and 41 inches at North Willamette. Of this, 25 percent usually falls in April through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 4.7 inches at Government Camp on December 22, 1964. Thunderstorms occur on about 7 days each year, and most of the storms occur in summer.

The average seasonal snowfall is 8 inches at Estacada, 314 inches at Government Camp, and 5 inches at North Willamette. The greatest snow depth at any one time during the period of record was 12 inches at Estacada, 180 inches at Government Camp, and 30 inches at North Willamette. On an average, Estacada has 2 days with at least 1 inch of snow on the ground, Government Camp has 95 days, and North Willamette

has 2 days. 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 90 percent. The sun shines 70 percent of the time in summer and 25 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 10 miles per hour, in winter.

In most winters, one or two storms over the whole area bring strong and sometimes damaging winds, and in some years the accompanying heavy rains cause serious flooding. Every few years, either in winter or in summer, a large invasion of a continental airmass from the east causes abnormal temperatures. In winter several consecutive days are well below freezing; in summer a week or longer is sweltering.

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 biologic 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 considerable 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. Soil taxonomy, 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 the soil survey was in progress, samples of some of the soils in the area were collected for laboratory analyses and for engineering tests. Soil scientists interpreted 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 were field tested through observation of the soils in different uses and under different levels of management. Some interpretations were modified to fit local conditions, and some new interpretations were developed to meet local needs. Data were 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 were 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 state with a fairly high degree of probability 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.

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, a map unit 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 other units 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 18 map units in this survey have been grouped into 5 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.

Soils dominantly on flood plains

Two map units are on these landscape positions. They make up about 5 percent of this survey area.

1. Cloquato-Newberg-McBee

Deep, well drained, somewhat excessively drained, and moderately well drained soils that formed in mixed alluvium

This map unit is in the western and northern parts of the survey area. The soils in this unit are on flood plains of major streams and are subject to flooding. Slope is 0 to 3 percent. The native vegetation is mainly black cottonwood, willows, ash, Douglas-fir, and blackberry. Elevation is 50 to 500 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit makes up about 4 percent of the survey area. It is about 35 percent Cloquato and similar soils, 20 percent Newberg and similar soils, and 15 percent McBee and similar soils. The remaining 30 percent is components of minor extent.

Cloquato soils are on flood plains. These soils are well drained and medium textured.

Newberg soils are on natural levees of flood plains. These soils are somewhat excessively drained and moderately coarse textured.

McBee soils are in slightly concave positions on flood plains. These soils are moderately well drained and moderately fine textured.

Of minor extent in this unit are well drained Chehalis soils, poorly drained Wapato soils, somewhat poorly drained McBee Variant soils, and excessively drained Camas soils.

Most areas of this unit are used for cultivated crops, mainly corn, beans, berries, and winter wheat. Among the other crops grown are alfalfa, pasture, and filberts. Some areas are used for recreation, wildlife habitat, and homesite development.

This unit is suited to cultivated crops. The main limitation is the hazard of flooding.

This unit is poorly suited to homesite development. The main limitation is the hazard of flooding.

2. Wapato-Cove

Deep, poorly drained soils that formed in alluvium

This map unit is in the northwestern part of the survey area. It is mainly in channels on flood plains. Slope is 0 to 3 percent. The native vegetation is mainly willows, ash, blackberry, and sedges. Elevation is 50 to 500 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit makes up about 1 percent of the survey area. It is about 50 percent Wapato and similar soils and 40 percent Cove and similar soils. The remaining 10 percent is components of minor extent.

Wapato soils are in channels on flood plains. These soils are poorly drained and moderately fine textured.

Cove soils are on flood plains and in drainageways. These soils are poorly drained and fine textured.

Of minor extent in this unit are poorly drained Humaquepts, ponded, and somewhat poorly drained Clackamas soils.

This unit is used for crops, including pasture, hay, and vegetables and as wildlife habitat.

If this unit is used for crops, the main limitations are the hazard of flooding and a seasonal high water table.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding, restricted permeability, and a seasonal high water table.

Soils dominantly on terraces

Six map units are on these landscape positions. They make up about 21 percent of this survey area.

3. Coburg-Conser

Deep, moderately well drained and poorly drained soils that formed in mixed silty and clayey alluvium

This map unit is in the western and northern parts of the survey area. It is mainly on low terraces along the Clackamas and Molalla Rivers. Slope is 0 to 3 percent. The native vegetation is mainly Douglas-fir, Oregon white oak, western hazel, blackberry, rose, sedges, and grasses. Elevation is 150 to 1,000 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit makes up about 1.5 percent of the survey area. It is about 35 percent Coburg and similar soils and 25 percent Conser and similar soils. The remaining 40 percent is components of minor extent.

Coburg and Conser soils are on low terraces. Coburg soils are moderately well drained, and Conser soils are poorly drained. Both soils are moderately fine textured in the upper part and fine textured in the lower part.

Of minor extent in this unit are well drained Salem and Malabon soils, somewhat poorly drained Clackamas soils, and poorly drained Cove soils.

Most areas of this unit are used for cultivated crops, mainly corn, winter wheat, and beans. Among the other crops grown are alfalfa, berries, nursery stock, and pasture. Some areas are used for homesite development and as wildlife habitat.

The main limitations of this unit for cultivated crops are restricted permeability and a seasonal high water table.

This unit is poorly suited to homesite development. The main limitations are low soil strength, restricted permeability, and a seasonal high water table.

4. Aloha-Woodburn

Deep, somewhat poorly drained and moderately well drained soils that formed in stratified glaciolacustrine deposits

This map unit is in the western and northern parts of the survey area. It is mainly on broad valley terraces incised by the Willamette River. Some areas are on long, narrow terraces incised by the Clackamas and Tualatin Rivers. Slope is 0 to 20 percent. The native vegetation is mainly Douglas-fir, Oregon white oak, western hazel, rose, Oregon-grape, and grasses. Elevation is 150 to 400 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit makes up about 13 percent of the survey area. It is about 40 percent Aloha and similar soils and 20 percent Woodburn and similar soils. The remaining 40 percent is components of minor extent.

Aloha soils are in nearly level and gently sloping areas on terraces. These soils are somewhat poorly drained and medium textured.

Woodburn soils are in nearly level to moderately steep, convex positions on broad terraces. These soils are moderately well drained. They are medium textured in the upper part and moderately fine textured in the lower part.

Of minor extent in this unit are poorly drained Dayton, Concord, and Huberly soils; well drained Willamette and Salem soils; and somewhat poorly drained Amity soils. Also included are poorly drained Wapato and Cove soils along many of the streams draining the terraces.

Most areas of this unit are used for cultivated crops, mainly corn, beans, winter wheat, strawberries, and nursery stock. Among the other crops grown are filberts (fig. 3), alfalfa, clover, and grass seed. Some areas are used for homesite development and timber production and as wildlife habitat.

This unit is well suited to cultivated crops. The main limitations are a seasonal high water table and restricted permeability.

If this unit is used for homesite development, the main limitations are a seasonal high water table and restricted permeability.

5. Willamette-Woodburn-Aloha

Deep, well drained to somewhat poorly drained soils that formed in stratified glaciolacustrine deposits

This map unit is in the northwestern part of the survey area. It is mainly on broad valley terraces incised by the Willamette River. Slope is 0 to 20 percent. The native vegetation is mainly Douglas-fir, Oregon white oak, western hazel, Oregon-grape, rose, and grasses. Elevation is 150 to 400 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit makes up about 2 percent of the survey area. It is about 35 percent Willamette and similar soils, 30 percent Woodburn and similar soils, and 25 percent Aloha and similar soils. The remaining 10 percent is components of minor extent.

Willamette and Woodburn soils are in nearly level to moderately steep, convex positions on broad terraces. The Willamette soils are well drained, and the Woodburn soils are moderately well drained. Both soils are medium textured in the upper part and moderately fine textured in the lower part.

About 80 percent of this unit is used for cultivated crops, mainly nursery stock, vegetables, winter wheat, filberts, and berries. The remaining 20 percent is used for homesite development.

This unit is well suited to cultivated crops and homesite development. It has few limitations.

7. Salem-Clackamas

Deep, well drained and somewhat poorly drained soils that formed in mixed gravelly alluvium

This map unit is in the northern part of the survey area. It is mainly on stream terraces along the Clackamas River, but some areas are on terraces of the Tualatin and Willamette Rivers. Slope is 0 to 12 percent. The native vegetation is mainly Douglas-fir, Oregon white oak, ash, rose, and grasses. Elevation is 175 to 500 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit makes up about 2 percent of the survey area. It is about 55 percent Salem and similar soils and 25 percent Clackamas and similar soils. The remaining 20 percent is components of minor extent.

Salem soils are in nearly level to sloping, slightly undulating areas on terraces. These soils are well drained. They are medium textured in the upper part and are very gravelly and coarse textured in the lower part.

Clackamas soils are in nearly level, slightly concave areas on terraces. These soils are somewhat poorly drained. They are medium textured in the upper part and are extremely gravelly and moderately fine textured in the lower part.

Of minor extent in this unit are well drained Multnomah soils and poorly drained Cove soils.

This unit is used mainly for homesite development and pasture. It is also used for crops such as winter wheat and vegetables, for timber production, and as wildlife habitat.

This unit is well suited to homesite development. The main limitation is a seasonal high water table in the Clackamas soils.

This unit is suited to cultivated crops. The main limitations are a seasonal high water table in the Clackamas soils and a high content of coarse fragments.

8. Crutch-Multorpor-Crutch Variant

Deep, moderately well drained, excessively drained, and poorly drained soils that formed in glacial outwash

This map unit is in the northeastern part of the survey area. It is mainly on stream terraces along the Sandy River. Slope is 0 to 8 percent. The native vegetation is mainly western hemlock, western redcedar, Douglas-fir, vine maple, red alder, and salmonberry. Elevation is 500 to 2,000 feet. The average annual precipitation is about 80 to 95 inches, the average annual air temperature is 46 to 50 degrees F, and the average frost-free period is 80 to 130 days.

This unit makes up about 1 percent of the survey area. It is about 40 percent Crutch and similar soils, 20 percent Multorpor and similar soils, and 15 percent Crutch Variant and similar soils. The remaining 25 percent is components of minor extent.

Crutch soils are in nearly level to gently sloping areas on terraces. These soils are moderately well drained. They are coarse textured throughout and are very cobbly in the lower part.

Multorpor soils are in nearly level to gently sloping areas on flood plains. These soils are excessively drained. They are very cobbly and coarse textured.

Crutch Variant soils are in concave, nearly level areas on terraces. These soils are poorly drained. They are coarse textured throughout and are very cobbly in the lower part.

Of minor extent in this unit are well drained Jimbo and Bull Run soils and somewhat poorly drained Bull Run Variant soils.

This unit is used mainly for homesite and recreational development and as wildlife habitat. Some areas are used for timber production.

If this unit is used for homesite development, the main limitations are a seasonal high water table and a high content on rock fragments in the Crutch soils and the hazard of flooding on the Multorpor soils.

Soils on rolling hills and high terraces

Five map units are on these landscape positions. They make up about 41 percent of the survey area.

9. Cascade-Powell

Deep, somewhat poorly drained soils that are underlain by a cemented layer and formed in silty material

This map unit is in the northern part of the survey area. It is mainly on rolling hills and high terraces. Slope is 0 to 60 percent. The native vegetation is mainly Douglas-fir, western redcedar, bigleaf maple, red alder, vine maple, Oregon-grape, salal, and trailing blackberry. Elevation is 250 to 1,400 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit makes up about 4 percent of the survey area. It is about 60 percent Cascade and similar soils and 25 percent Powell and similar soils. The remaining 15 percent is components of minor extent.

Cascade soils are on rolling hills, and Powell soils are on rolling hills and high terraces. These soils are somewhat poorly drained and medium textured.

Of minor extent in this unit are moderately well drained Kinton and Cornelius soils. Also of minor extent are poorly drained Delena and Borges soils in drainageways.

Figure 3.—Filbert orchard in an area of Aloha silt loam that has been artificially drained.

Aloha soils are in nearly level to gently sloping areas on terraces. These soils are somewhat poorly drained and medium textured.

Of minor extent in this unit are moderately well drained Quatama soils, well drained Latourell soils, and poorly drained Dayton soils.

Most areas of this unit are used for cultivated crops, mainly winter wheat, filberts, and strawberries. Among the other crops grown are nursery stock, alfalfa, potatoes, and pasture. Some areas are used for homesite development and timber production and as wildlife habitat.

This unit is well suited to cultivated crops. The main limitation is a seasonal high water table in the Aloha and Woodburn soils.

The main limitations of this unit for homesite development are low soil strength and a seasonal high water table in the Aloha and Woodburn soils.

6. Latourell-Canderly

Deep, well drained and somewhat excessively drained soils that formed in stratified glaciolacustrine deposits

This map unit is in the western part of the survey area, near the mouth of the Molalla River. It is on broad valley terraces incised by the Willamette River. Slope is 0 to 30 percent. The native vegetation is mainly Douglas-fir, Oregon white oak, western hazel, Oregon-grape, and grasses. Elevation is 50 to 250 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit makes up about 1.5 percent of the survey area. It is about 50 percent Latourell and similar soils and 25 percent Canderly and similar soils. The remaining 25 percent is components of minor extent.

Latourell soils are in nearly level to moderately steep, slightly convex areas on terraces. These soils are well drained and medium textured.

Canderly soils are in nearly level to gently sloping areas on low terraces. These soils are somewhat excessively drained and moderately coarse textured.

Of minor extent in this unit are moderately well drained Quatama and Woodburn soils and poorly drained Concord soils.

This unit is used mainly for pasture, homesites, and timber production. It is also used for cultivated crops, recreation, and wildlife habitat.

If this unit is used for cultivated crops, the main limitations are a seasonal high water table and restricted rooting depth. Slope is a limitation in the steeper areas of the unit.

If this unit is used for homesite development, the main limitations are a seasonal high water table and low soil strength. Slope is a limitation in the steeper areas of the unit.

10. Jory-Saum

Deep, well drained soils that formed in colluvium derived dominantly from basalt

This map unit is in the central and western parts of the survey area. It is mainly on rolling hills. Slope is 2 to 60 percent. The native vegetation is mainly Douglas-fir, Oregon white oak, western hazel, Oregon-grape, and trailing blackberry. Elevation is 250 to 1,200 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit makes up about 17 percent of the survey area. It is about 50 percent Jory and similar soils and 15 percent Saum and similar soils. The remaining 35 percent is components of minor extent.

Jory soils are on rolling hills. These soils are well drained. They are moderately fine textured in the upper part and fine textured in the lower part.

Saum soils are on rolling hills. These soils are well drained. They are medium textured in the upper part and fine textured in the lower part.

Of minor extent in this unit are well drained Laurelwood soils, moderately well drained Cottrell and Bornstedt soils, somewhat poorly drained Hardscrabble soils, and poorly drained Borges soils. Also of minor extent are moderately deep Nekia and Ritner soils and shallow Witzel soils.

This unit is used mainly for hay and pasture and for timber production. It is also used for crops such as berries, filberts, and small grain, as homesites and wildlife habitat, and for recreation.

If this unit is used for cultivated crops, the main limitations are the acidity of the soils and low soil fertility. Slope is a limitation in the steeper areas of the unit.

If this unit is used for homesite development, the main limitations are low soil strength and restricted permeability. Slope is a limitation in the steeper areas of the unit.

11. Bornstedt-Cottrell

Deep, moderately well drained soils that formed in old alluvium and in silty material overlying old clayey alluvium

This map unit is in the northern part of the survey area. It is mainly on rolling hills and high terraces. Slope is 0 to 30 percent. The native vegetation is mainly Douglas-fir, western redcedar, red alder, western hazel, swordfern, and trailing blackberry. Elevation is 400 to 900 feet. The average annual precipitation is about 50 to 65 inches, the average annual air temperature is 50 to 53 degrees F, and the average frost-free season is 140 to 200 days.

This unit makes up about 4 percent of the survey area. It is about 55 percent Bornstedt and similar soils and 35 percent Cottrell and similar soils. The remaining 10 percent is components of minor extent.

Bornstedt soils are on rolling hills and high terraces. These soils formed in silty material overlying old clayey alluvium. They are moderately well drained and medium textured.

Cottrell soils are on rolling hills and high terraces. These soils formed in old alluvium. They are moderately well drained and moderately fine textured.

Of minor extent in this unit are somewhat poorly drained Cascade soils and poorly drained Borges and Delena soils in drainageways.

Most areas of this unit are used for cultivated crops, mainly strawberries, raspberries, nursery stock, and filberts. Among the other crops grown are wheat, pasture, hay, and potatoes. Some areas are used as homesites, for recreational development, and as wildlife habitat.

If this unit is used for cultivated crops, the main limitations are slope in the steeper areas of the unit and a seasonal high water table.

If this unit is used for homesite development, the main limitations are a seasonal high water table and restricted permeability. Slope is a limitation in the steeper areas of the unit.

12. Alspaugh-Cazadero-Molalla

Deep, well drained soils that formed in old alluvium and in colluvium

This map unit is in the northeastern part of the survey area. It is mainly on rolling hills and high terraces. Slope is 0 to 50 percent. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, western hazel, vine maple, and Oregon-grape. Elevation is 600 to 1,800 feet. The average annual precipitation is about 60 to 85 inches, the average annual air temperature is about 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

This unit makes up about 14 percent of the survey area. It is about 40 percent Alspaugh and similar soils, 20 percent Cazadero and similar soils, and 10 percent Molalla and similar soils. The remaining 30 percent is components of minor extent.

Alspaugh soils are in gently sloping to steep areas on high terraces and rolling hills. These soils formed in colluvium derived dominantly from andesite and tuff. They are well drained and moderately fine textured.

Cazadero soils are in nearly level to moderately steep areas on high terraces. These soils formed in mixed old alluvium. They are well drained and moderately fine textured.

Molalla soils are in gently sloping to moderately steep areas on rolling hills. These soils formed in colluvium derived from tuff, breccia, and andesite. They are well drained and medium textured.

Of minor extent in this unit are well drained Klickitat and Kinney soils, moderately well drained Cottrell soils, and poorly drained Borges soils.

This unit is used mainly for timber production and pasture. It is also used for crops such as berries and nursery stock, as homesites and wildlife habitat, and for recreation.

If this unit is used for homesite development, the main limitations are restricted permeability and low soil strength. Slope is a limitation in the steeper areas of the unit.

13. Springwater-Gapcot

Moderately deep and shallow, well drained soils that formed in colluvium derived from sandstone

This map unit is in the southwestern part of the survey area. It is mainly on rolling hills. Slope is 3 to 60 percent. The native vegetation on the Springwater soils is mainly Douglas-fir, bigleaf maple, western hazel, Oregon-grape, and salal. The native vegetation on the Gapcot soils is mainly Oregon white oak, poison-oak, trailing blackberry, and grasses. Elevation is 500 to 1,800 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 160 to 200 days.

This unit makes up about 2 percent of the survey area. It is about 65 percent Springwater and similar soils and 15 percent Gapcot and similar soils. The remaining 20 percent is components of minor extent.

Springwater soils are on rolling hills. These soils are moderately deep, well drained, and medium textured.

Gapcot soils are on rolling hills. These soils are shallow, well drained, and medium textured.

Of minor extent in this unit are well drained Nekia soils, moderately well drained Cottrell soils, and somewhat poorly drained Hardscrabble soils.

Most areas of this unit are used for timber production, wildlife habitat, and pasture. A few areas are used for crops such as grass seed and small grain and as homesites.

If this unit is used for cultivated crops or homesite development, the main limitations are shallow depth to bedrock in the Gapcot soils and steepness of slope in much of the unit.

Soils on rolling hills and on mountains

Three map units are on these landscape positions. They make up about 25 percent of this survey area.

14. Aschoff-Bull Run

Deep, well drained soils that formed in colluvium and in silty material

This map unit is on mountains in the northeastern part of the survey area. Slope is 3 to 90 percent. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, bigleaf maple, western hazel, swordfern, and trailing blackberry. Elevation is 500 to 2,000 feet. The average annual precipitation is about 60 to 95 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

This unit makes up about 6 percent of the survey area. It is about 55 percent Aschoff and similar soils and 30 percent Bull Run and similar soils. The remaining 15 percent is components of minor extent.

Aschoff soils are in sloping to very steep areas on mountains. These soils formed in colluvium derived from andesite and basalt and mixed with volcanic ash. The soils are well drained and medium textured.

Bull Run soils are in gently sloping to steep areas on mountains. These soils formed in silty material that is high in content of volcanic ash. The soils are well drained and medium textured.

Of minor extent in this unit are well drained Alspaugh and Brightwood soils and somewhat poorly drained Bull Run Variant soils.

Most areas of this unit are used for timber production, wildlife habitat, and recreation. A few areas are used for pasture (fig. 4), raspberries, and homesites.

If this unit is used for pasture and berries, the main limitation is a short growing season. Slope is a limitation in the steeper areas of the unit.

If this unit is used for homesite development, the main limitations are the content of rock fragments in the Aschoff soils and slope in the steeper areas of the unit.

15. Klickitat-Kinney-McCully

Deep, well drained soils that formed in colluvium

This map unit is in the southeastern part of the survey area. It is on mountains and rolling hills. The unit is characterized by large unstable areas. Slope is 2 to 60 percent. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, western hazel, vine maple, salal, Oregon-grape, and swordfern. Elevation is 800 to 2,000 feet. The average annual precipitation is about 60 to 90 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 120 to 165 days.

This unit makes up about 7 percent of the survey area. It is about 40 percent Klickitat and similar soils, 35 percent Kinney and similar soils, and 10 percent McCully and similar soils. The remaining 15 percent is components of minor extent.

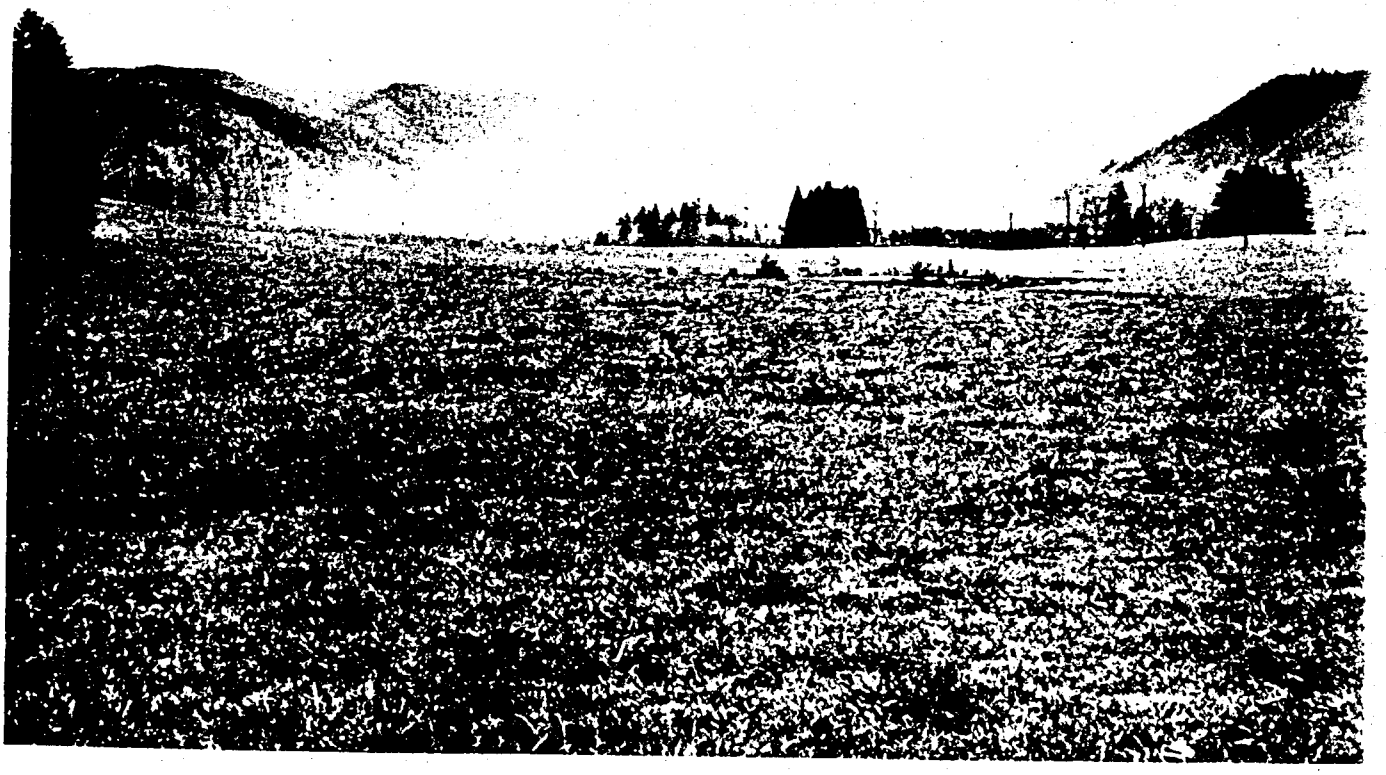


Figure 4.—Improved pasture in an area of Bull Run soils.

Klickitat soils are on mountains. These soils formed in colluvium derived dominantly from andesite and basalt. They are well drained and are medium textured in the upper part and moderately fine textured in the lower part.

Kinney soils are on rolling hills. These soils formed in colluvium derived from tuff and breccia. They are well drained and medium textured.

McCully soils are on rolling hills. These soils formed in colluvium derived dominantly from basalt and andesite. They are well drained and are medium textured in the upper part and fine textured in the lower part.

Of minor extent in this unit are well drained Aschoff soils and moderately well drained Cottrell soils.

Most areas of this unit are used for timber production, wildlife habitat, and recreation. A few areas are used for pasture and as homesites.

If this unit is used for homesite development, the main limitations are low soil strength and the high content of rock fragments in the Klickitat and Kinney soils. Slope is a limitation in the steeper areas of the unit.

16. Fernwood-Zygore-Wilhoit

Moderately deep and deep, well drained soils that formed in colluvium derived from andesite and basalt and mixed with volcanic ash

This map unit is in the eastern part of the survey area. It is mainly on mountains. Slope is 5 to 90 percent. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, vine maple, Oregon-grape, salal, and swordfern. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 70 to 100 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 110 days.

This unit makes up about 12 percent of the survey area. It is about 25 percent Fernwood and similar soils, 25 percent Zygore and similar soils, and 25 percent Wilhoit and similar soils. The remaining 25 percent is components of minor extent.

Fernwood soils are in sloping to very steep areas on mountains. These soils are moderately deep and well drained. They are very gravelly and medium textured.

Zygore soils are in sloping to very steep areas on mountains. These soils are deep and well drained. They are very cobbly in the lower part and are medium textured throughout.

Wilhoit soils are in sloping to steep areas on mountains. These soils are deep, well drained, and medium textured.

Of minor extent in this unit are well drained Memaloose soils, poorly drained Andic Cryaquepts, and areas of Rock outcrop.

This unit is used for timber production, wildlife habitat, and recreation.

Cold soils on mountains

Two map units are on these landscape positions. They make up about 8 percent of this survey area.

17. Highcamp-Kinzel

Deep, well drained soils that formed in colluvium derived from andesite and basalt and mixed with volcanic ash

This map unit is on mountains in the southeastern part of the survey area. Slope is 5 to 90 percent. The native vegetation is mainly noble fir, western hemlock, Douglas-fir, western redcedar, red alder, vine maple, rhododendron, big huckleberry, and beargrass. Elevation is 2,800 to 4,000 feet. The average annual precipitation is about 70 to 110 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 20 to 45 days.

This unit makes up about 7 percent of the survey area. It is about 55 percent Highcamp and similar soils and 25 percent Kinzel and similar soils. The remaining 20 percent is components of minor extent.

Highcamp soils are on mountains. These soils are very gravelly in the upper part and very cobbly in the lower part. They are well drained and medium textured throughout.

Kinzel soils are on mountains. These soils are very gravelly in the upper part and extremely cobbly in the lower part. They are well drained and are medium textured throughout.

Of minor extent in this unit are well drained Divers and Soosap soils, well drained Cryochrepts, poorly drained Andic Cryaquepts, and areas of Rock outcrop.

This unit is used for timber production, wildlife habitat, and recreation.

18. Newanna-Talapus-Lastance

Deep and moderately deep, well drained soils that formed in colluvium derived mainly from andesite and basalt

This map unit is in the southeastern part of the survey area. It is mainly on mountains. Slope is 5 to 90 percent. The native vegetation is mainly noble fir, Pacific silver fir, mountain hemlock, big huckleberry, rhododendron, and beargrass. Elevation is 3,500 to 5,000 feet. The average annual precipitation is about 80 to 110 inches, the average annual air temperature is 38 to 42 degrees F, and the average frost-free period is 10 to 30 days.

This unit makes up about 1 percent of the survey area. It is about 35 percent Newanna and similar soils, 25 percent Talapus and similar soils, and 15 percent Lastance and similar soils. The remaining 25 percent is components of minor extent.

Newanna soils are in sloping to very steep areas on mountains. These soils are moderately deep and well drained. They are very gravelly and medium textured.

Talapus soils are in sloping to steep areas on mountains. These soils are deep and well drained. They are very gravelly in the upper part and extremely gravelly in the lower part. The soils are medium textured throughout.

Lastance soils are in sloping to steep areas on mountains. These soils are deep and well drained. They are stony in the upper part and very cobbly in the lower part. The soils are coarse textured throughout.

Of minor extent in this unit are moderately deep, well drained Thader soils; shallow and moderately deep, well drained Cryochrepts; deep and very deep, poorly drained Andic Cryaquepts; and areas of Rock outcrop.

This unit is used for timber production, wildlife habitat, and recreation.

Broad Land Use Considerations

The survey area has a wide variety of soils that vary in their potential for major land uses. Major land uses within the area are cultivated crops, pasture, timber production, and homesite development. About 15 percent of the area is used for cultivated crops, mainly wheat, vegetables, berries, filberts, and nursery stock. Most of the cropland is in areas of general soil map units 1, 3, 4, 5, 6, 10, and 11. These areas are well suited to crops. The soils in map unit 1 are subject to flooding, which can result in damage to some crops. Wetness is the main limitation for crops in areas of units 3, 4, 5, and 11. Units 2, 7, 9, 12, and 13 are only moderately suited to cultivated crops. Wetness is the main limitation for crops on units 2, 7, and 9.

Hay and pasture are grown extensively in areas of map units 9, 10, 12, and 13. Wetness is the main limitation for grazing on unit 9.

Timber is produced on about 50 percent of the survey area. The production of Douglas-fir is high on map units 10, 12, 13, 14, 15, and 16, moderate on unit 17, and low on unit 18. Production on units 17 and 18 is limited by the cold temperatures. The main limitation for timber management is steepness of slope.

About 55,000 acres of the survey area is used for homesite development. This acreage is mainly in map

units 4, 7, and 9. Units 5, 6, 10, 11, and 12 are well suited to homesite development. Units 1 and 2 are poorly suited to homesite development because of the hazard of flooding.

The potential for wildlife habitat generally is high throughout the survey area. The soils in map units 1 through 7 have high potential as habitat for openland wildlife. The soils on flood plains in units 1 and 2 have moderate potential as habitat for wetland wildlife. The soils in units 8 through 18 have high potential as habitat for woodland wildlife.

The suitability for recreation ranges from poor to good, depending on the intensity of expected use. Intensive recreational developments such as playgrounds and camping areas are well suited to units 3, 4, 5, 6, 7, and 10. All units are well suited to seasonal recreational activities such as hunting, hiking, and horseback riding.

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 of 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 and miscellaneous areas 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 behavior 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 to precisely define and locate the soils and miscellaneous areas is needed.

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, Jory silty clay loam, 2 to 8 percent slopes, is one of several phases in the Jory series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are 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. Highcamp-Soosap complex, 5 to 30 percent slopes, is an example.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Riverwash 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

1A—Aloha silt loam, 0 to 3 percent slopes. This deep, somewhat poorly drained soil is on broad valley terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, snowberry, rose, tall Oregon-grape, grasses, and forbs. Elevation is 150 to 350 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The upper 27 inches of the subsoil is dark brown, dark grayish brown, and yellowish brown silt loam, and the lower 16 inches is dark grayish brown and dark brown loam. The upper 9 inches of the substratum is dark brown loam. Below this are dark grayish brown, stratified very fine sandy loam and silt loam. The lower part of the subsoil and the upper part of the substratum in places are slightly brittle and weakly cemented.

Included in this unit are small areas of Woodburn, Quatama, Huberly, and Dayton soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Aloha soil is moderately slow. Available water capacity is 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 12 to 24 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly sweet corn, bush beans, winter wheat, and pasture. Among the other crops grown are filberts, strawberries, and grass seed. Some areas of the unit are used for homesite development and wildlife habitat. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 80 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Aloha soils that have been cut or graded.

This unit is suited to crops. It is limited mainly by wetness and droughtiness. Most climatically adapted crops can be grown if drainage is provided. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation of the soil in this unit can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are wetness and the moderately slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods.

Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass IIw.

1B—Aloha silt loam, 3 to 6 percent slopes. This deep, somewhat poorly drained soil is on broad valley terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, snowberry, rose, tall Oregon-grape, grasses, and forbs. Elevation is 150 to 350 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The upper 27 inches of the subsoil is dark brown, dark grayish brown, and yellowish brown silt loam, and the lower 16 inches is dark grayish brown and dark brown loam. The upper 9 inches of the substratum is dark brown loam. Below this are stratified very fine sandy loam and silt loam. The lower part of the subsoil and upper part of the substratum in places are slightly brittle and weakly cemented.

Included in this unit are small areas of Woodburn, Quatama, Huberly, and Dayton soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Aloha soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 12 to 24 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly sweet corn, bush beans, winter wheat, and pasture. Among the other crops grown are filberts, strawberries, and grass seed. This unit is also used for homesite development and wildlife habitat. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 80 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Aloha soils that have been cut or graded.

This unit is suited to crops. It is limited mainly by wetness and droughtiness. Most climatically adapted crops can be grown if drainage is provided. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation of the soil in this unit can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are wetness and the moderately slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods.

Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass IIw.

2B—Alspaugh clay loam, 2 to 8 percent slopes. This deep, well drained soil is on high terraces and rolling uplands. It formed in alluvium and colluvium derived dominantly from andesite and tuff. The vegetation in areas not cultivated is mainly Douglas-fir, red alder, salal, brackenfern, and swordfern. Elevation is 800 to 1,800 feet. The average annual precipitation is about 60 to 85 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark brown clay loam about 14 inches thick. The subsoil is dark brown and reddish brown clay about 29 inches thick. The substratum to a depth of 60 inches or more is reddish brown very gravelly clay.

Included in this unit are small areas of Cazadero, Kinney, McCully, and Aschoff soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Alspaugh soil is moderately slow. Available water capacity is about 5.5 to 9.5 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for timber production. It is also used for pasture, hay, homesites, wildlife habitat, and recreation.

If this unit is used for pasture and hay, the main limitations are the moderately slow permeability and the clayey texture of the soil. A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling can be used to break up the tillage pan. Including grasses, legumes, or grass-legume mixtures in the cropping system helps to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. If the soil in this unit is plowed during the rainy season in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 143 to 159. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suited to the unit, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads need heavy base rock for year-round use. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as alder limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the moderately slow permeability and shrink-swell potential. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Excavation for roads and buildings increases the risk of erosion. Preserving the existing

plant cover during construction helps to control erosion. If this unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability.

This map unit is in capability subclass IIIe.

2C—Alspaugh clay loam, 8 to 15 percent slopes. This deep, well drained soil is on high terraces and rolling uplands. It formed in alluvium and colluvium derived dominantly from andesite and tuff. The vegetation in areas not cultivated is mainly Douglas-fir, red alder, salal, brackenfern, and swordfern. Elevation is 800 to 1,800 feet. The average annual precipitation is about 60 to 85 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark brown clay loam about 14 inches thick. The subsoil is dark brown and reddish brown clay about 29 inches thick. The substratum to a depth of 60 inches or more is reddish brown very gravelly clay.

Included in this unit are small areas of Cazadero, Kinney, McCully, and Aschoff soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Alspaugh soil is moderately slow. Available water capacity is about 5.5 to 9.5 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly for timber production. It is also used for hay, pasture, homesites, wildlife habitat, and recreation.

If this unit is used for hay and pasture, the main limitations are slope, the moderately slow permeability, and the clayey texture of the soil. Grasses and legumes grow well if adequate fertilizer is used. Seedbed preparation should be on the contour or across the slope where practical. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 143 to 159. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Roads need heavy base rock for year-round use. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as alder and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, the moderately slow permeability, and shrink-swell potential. Roads and buildings should be designed to offset the limited ability of the soil to support a load. Excavation for roads and buildings increases the risk of erosion. Preserving the existing plant cover during construction helps to control erosion.

If this unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. The steepness of slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass IVe.

2D—Alspaugh clay loam, 15 to 30 percent slopes. This deep, well drained soil is on high terraces and rolling uplands. It formed in alluvium and colluvium derived dominantly from andesite and tuff. The vegetation in areas not cultivated is mainly Douglas-fir, red alder, salal, brackenfern, and swordfern. Elevation is 800 to 1,800 feet. The average annual precipitation is about 60 to 85 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark brown clay loam about 14 inches thick. The subsoil is dark brown and reddish brown clay about 29 inches thick. The substratum to a depth of 60 inches or more is reddish brown very gravelly clay.

Included in this unit are small areas of McCully, Kinney, Aschoff, and Cazadero soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Alspaugh soil is moderately slow. Available water capacity is about 5.5 to 9.5 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly for timber production. It is also used for pasture, homesites, wildlife habitat, and recreation.

If this unit is used for hay and pasture, the main limitations are steepness of slope, the moderately slow permeability, and the clayey texture of the soil. Grasses and legumes grow well if adequate fertilizer is used. Seedbed preparation should be on the contour or across the slope where practical. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 143 to 159. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are slope and the hazard of erosion. The steepness of slope limits the kinds of equipment that can be used in forest management. Roads need heavy base rock for year-round use. Roads and landings can be protected from erosion by constructing water bars and by seeding

cuts and fills. Brushy plants such as alder and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, moderately slow permeability, shrink-swell potential, and the hazard of erosion. Excavation for roads and buildings increases the risk of erosion. Preserving the existing plant cover during construction helps to control erosion. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

If this unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. The steepness of slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass VIe.

2E—Alspaugh clay loam, 30 to 50 percent slopes. This deep, well drained soil is on high terraces and rolling uplands. It formed in alluvium and colluvium derived dominantly from andesite and tuff. The native vegetation is mainly Douglas-fir, red alder, salal, brackenfern, and swordfern. Elevation is 800 to 1,800 feet. The average annual precipitation is about 60 to 85 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark brown clay loam about 14 inches thick. The subsoil is dark brown and reddish brown clay about 29 inches thick. The substratum to a depth of 60 inches or more is reddish brown very gravelly clay.

Included in this unit are small areas of McCully, Kinney, and Aschoff soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Alspaugh soil is moderately slow. Available water capacity is about 5.5 to 9.5 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 143 to 159. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are slope and the hazard of erosion. Conventional methods of harvesting trees are difficult to use on this unit because of the steepness of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during November through March. Roads need heavy base rock for year-round use. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as alder and salal limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

3—Amity silt loam. This deep, somewhat poorly drained soil is on broad valley terraces. It formed in stratified glaciolacustrine deposits. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, wild rose, willow, and grasses. Elevation is 150 to 350 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 15 inches thick. The subsurface layer is dark gray silt loam about 7 inches thick. The subsoil is grayish brown and light olive brown silty clay loam about 13 inches thick. The substratum to a depth of 60 inches or more is olive brown silty clay loam.

Included in this unit are small areas of Woodburn, Aloha, Dayton, and Huberly soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Amity soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 6 to 18 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for cultivated crops and pasture. The main cultivated crops are sweet corn and bush beans. Among the other crops grown are winter wheat, blackberries, filberts, and grass seed. This unit is also used for homesite development, wildlife habitat, and recreation.

This unit is suited to crops. It is limited mainly by wetness. Most climatically adapted crops can be grown if drainage is provided. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation of the soil can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are wetness and the moderately slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain

tile around footings. Septic tank absorption fields do not function properly during rainy periods.

Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. Drainage is needed for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass IIw.

4E—Andic Cryaquepts, moderately steep. These moderately deep to deep, very poorly drained soils are along drainageways of high mountainous uplands. They formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Slope is 5 to 30 percent. The native vegetation is mainly red alder, mountain alder, and devilsclub with scattered western hemlock and western redcedar (fig. 5). Elevation is 2,700 to 4,000 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is 40 to 45 degrees F, and the average frost-free period is 30 to 90 days.

No single profile of Andic Cryaquepts is typical, but one commonly observed in the survey area has a surface layer of cobbly sandy loam about 7 inches thick. The subsoil is very gravelly sandy loam about 19 inches thick. The substratum to a depth of 60 inches or more is compacted, slightly brittle very cobbly sandy loam. In some areas of similar included soils, the surface layer is silt loam or loam. Depth to bedrock is 30 to 60 inches or more.

Included in this unit are small areas of Highcamp, Soosap, and Kinzel soils and Rock outcrop. Also included are small areas of organic soils in the more

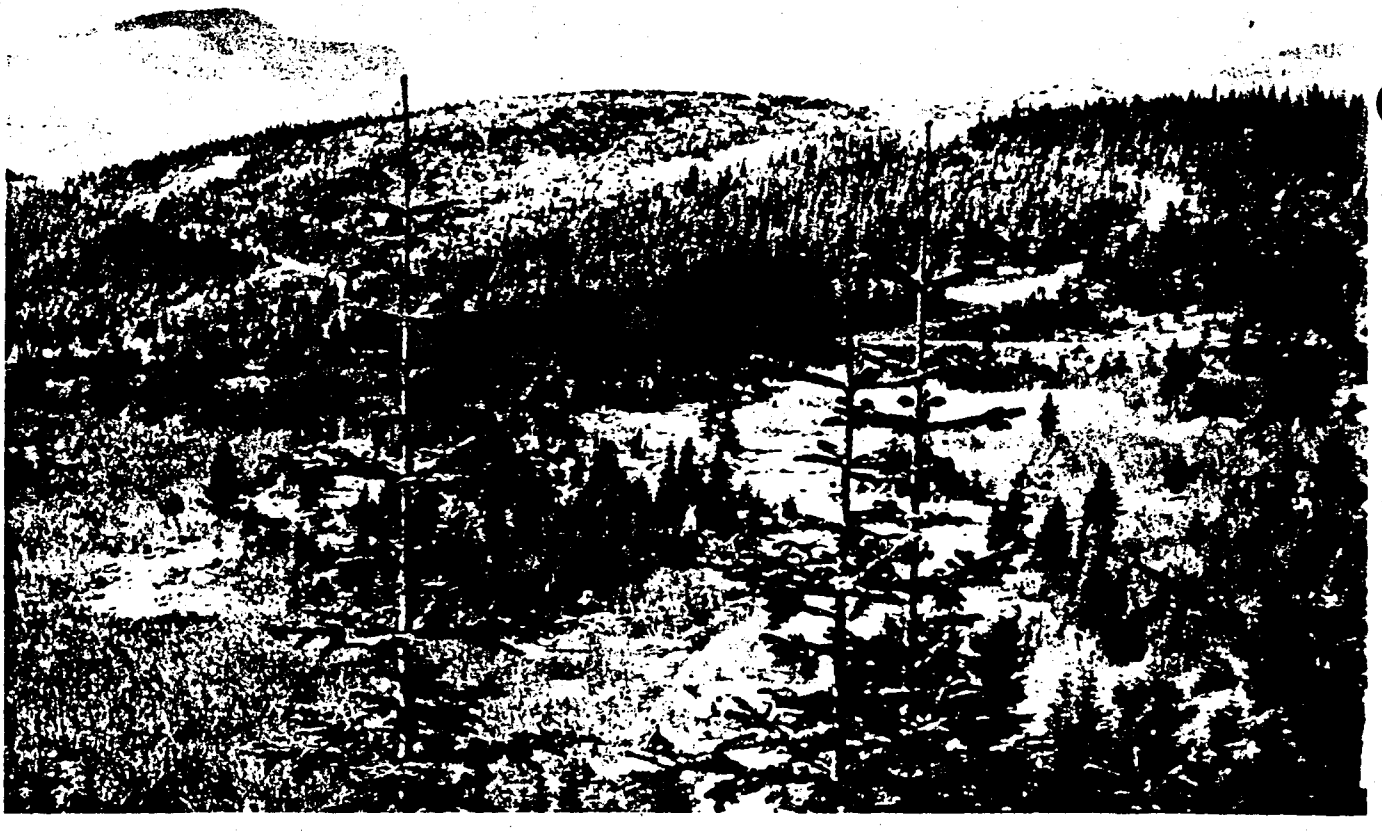


Figure 5.—Andic Cryaquepts, moderately steep, in foreground. Highcamp and Soosap soils in background.

nearly level areas. Included areas make up about 20 percent of the total acreage.

Permeability of the Andic Cryaquepts is moderately rapid to a depth of 26 inches and moderately slow below this depth. Available water capacity is about 5 to 10 inches. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 0 to 6 inches.

This unit is used as water supply and wildlife habitat.

This map unit is in capability subclass VIe.

4F—Andic Cryaquepts, steep. These moderately deep to deep, poorly drained soils are on slightly concave side slopes and in drainage basins in high mountainous areas. They formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Slope is 30 to 90 percent. The native vegetation is mainly devilsclub and mountain alder with scattered Douglas-fir, western hemlock, western redcedar, and red alder. Elevation is 2,700 to 4,000 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is 40 to 45 degrees F, and the average frost-free period is 10 to 45 days.

No single profile of Andic Cryaquepts is typical, but one commonly observed in the survey area has a surface layer of cobbly sandy loam about 7 inches thick. The subsoil is very gravelly sandy loam about 19 inches thick. The substratum to a depth of 60 inches or more is compacted, slightly brittle very cobbly sandy loam. In some areas of similar included soils, the surface layer is silt loam or loam. Depth to bedrock is 30 to 60 inches or more.

Included in this unit are small areas of Highcamp, Soosap, and Kinzel soils and Rock outcrop. Included areas make up about 25 percent of the total acreage.

Permeability of the Andic Cryaquepts is moderately rapid to a depth of 26 inches and moderately slow below this depth. Available water capacity is about 5 to 10 inches. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe. Water is perched above the compacted substratum.

This unit is used as water supply and wildlife habitat.

This map unit is in capability subclass VIIe.

5D—Aschoff cobbly loam, 5 to 30 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in colluvium derived from andesite and basalt mixed with volcanic ash. The native vegetation is mainly Douglas-fir, western hemlock, red alder, oxalis, salal, swordfern, and vine maple. Elevation is 500 to 2,000 feet. The average annual precipitation is about 60 to 95 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is very dark brown and very dark grayish brown cobbly loam about 17 inches thick. The subsoil is dark brown very cobbly loam about 11 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown very gravelly loam.

Included in this unit are small areas of Bull Run, Kinney, and Brightwood soils. Included areas make up about 25 percent of the total acreage.

Permeability of this Aschoff soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production, wildlife habitat, recreation, and homesites.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 155. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the high content of coarse fragments. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as red alder and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the high content of coarse fragments and steepness of slope. The steepness of slope is a concern in installing septic tank absorption fields.

Preserving the existing plant cover during construction helps to control erosion. Removal of gravel and cobbles in disturbed areas is required for best results when landscaping, particularly in areas used for lawns. Mulch, fertilizer, and irrigation are needed to establish lawn grasses and other small seeded plants.

This map unit is in capability subclass VIs.

5E—Aschoff cobbly loam, 30 to 60 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in colluvium derived from andesite and basalt mixed with volcanic ash. The native vegetation is mainly Douglas-fir, western hemlock, red alder, oxalis, salal, swordfern, and vine maple. Elevation is 500 to 2,000 feet. The average annual precipitation is about 60 to 95 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is very dark brown and very dark grayish brown cobbly loam about 17 inches thick. The subsoil is dark brown very cobbly loam about 11 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown very cobbly loam.

Included in this unit are small areas of Brightwood, Kinney, and Bull Run soils and Rubble land. Included areas make up about 25 percent of the total acreage.

Permeability of this Aschoff soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 155. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are steepness of slope and the high content of coarse fragments. Conventional methods of harvest are difficult to use because of the steepness of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during December through March. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as red alder and vine maple limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIs.

6F—Aschoff-Brightwood complex, 60 to 90 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, salal, swordfern, and oxalis. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 80 to 95 inches, the average annual air temperature is 48 to 51 degrees F, and the average frost-free period is 140 to 180 days.

This unit is about 50 percent Aschoff cobbly loam and 30 percent Brightwood very gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Rock outcrop and Klickitat and Kinney soils. Included areas make up about 20 percent of the total acreage.

The Aschoff soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is very dark brown and very dark grayish brown cobbly loam about 17 inches thick. The subsoil is dark brown very cobbly loam about 11 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown very cobbly loam.

Permeability of the Aschoff soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

The Brightwood soil is moderately deep and well drained. It formed in colluvium derived dominantly from tuff and breccia. Typically, the surface layer is dark brown very gravelly loam about 4 inches thick. The subsoil is dark brown very cobbly loam about 14 inches thick. The substratum is brown extremely gravelly loam about 16 inches thick over tuffaceous bedrock.

Permeability of the Brightwood soil is moderately rapid. Available water capacity is about 2 to 5 inches. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. On the Ascoff soil, the site index for Douglas-fir ranges from 140 to 155. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

On the Brightwood soil, the site index for Douglas-fir ranges from 125 to 135. On the basis of a site index of 130, the potential production per acre of merchantable timber is 7,740 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 75,690 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are steepness of slope and the content of rock fragments and restricted rooting depth of the Brightwood soil. Conventional methods of harvesting timber are difficult to use because of slope. Highlead or other logging methods that fully or partially suspend logs reduce disturbance of the soil in this unit. Severe erosion or gullying can occur where the soil is disturbed. Landsliding and slumping can result where roads are constructed. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Trees on the Brightwood soil are subject to windthrow because of the restricted rooting depth. Brushy plants such as red alder and vine maple limit natural regeneration of Douglas-fir on this unit.

This map unit is in capability subclass VIIe.

7B—Borges silty clay loam, 0 to 8 percent slopes. This deep, poorly drained soil is in concave areas on rolling uplands and high terraces. It formed in mixed clayey alluvium. The vegetation in areas not cultivated is mainly alder, ash, western redcedar, Douglas-fir, and swordfern. Elevation is 300 to 650 feet. The average annual precipitation is about 48 to 65 inches, the average annual air temperature is 50 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is very dark gray and very dark grayish brown silty clay loam about 12 inches thick. The subsoil is dark grayish brown silty clay loam about 6 inches thick. The upper 27 inches of the substratum is dark gray and grayish brown silty clay, and the lower part to a depth of 60 inches or more is brown and grayish brown clay loam. Depth to the clayey substratum ranges from 15 to 25 inches.

Included in this unit are small areas of Delena, Cottrell, Bornstedt, Powell, and Cascade soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Borges soil is very slow. Available water capacity is about 3 to 5 inches. Effective rooting depth is restricted by the clayey substratum. Runoff is slow to ponded, and the hazard of water erosion is slight. The water table is at a depth of 0 to 6 inches in winter and early in spring.

This unit is used for pasture, hay, homesite development, and wildlife habitat.

If this unit is used for hay and pasture, the main limitations are wetness and the very slow permeability. Wetness limits the choice of suitable plants and the period of cutting or grazing and increases the risk of winterkill. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed for best growth of grasses and legumes on this unit.

If this unit is used for homesite development, the main limitations are wetness, shrink-swell potential, and low soil strength. Drainage is needed if roads and buildings are constructed; however, it is difficult to install because of the very slow permeability of the clayey substratum. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. Septic tank absorption fields do not function properly because of wetness and the very slow permeability.

This map unit is in capability subclass IVw.

8B—Bornstedt silt loam, 0 to 8 percent slopes. This deep, moderately well drained soil is on high terraces and rolling uplands. It formed in mixed old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, hazel, and vine maple. Elevation is 400 to 650 feet. The average annual precipitation is about 48 to 65 inches, the average annual air temperature is 50 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is very dark brown silt loam about 8 inches thick. The upper 20 inches of the subsoil is reddish brown silty clay loam, and the lower 5 inches is brown silty clay loam. Below this to a depth of 60 inches or more is brittle, reddish brown and reddish gray clay and variegated reddish brown and brown silty clay. Depth to the brittle layer ranges from 30 to 40 inches.

Included in this unit are small areas of Borges, Powell, Cazadero, and Jory soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Bornstedt soil is slow. Available water capacity is about 3 to 7 inches. Effective rooting depth is restricted by the brittle layer. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly nursery stock, strawberries, and raspberries (fig. 6). Among the other crops grown are potatoes, small grain, filberts, hay, and pasture. Some areas are used as homesites and for recreation and wildlife habitat. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Bornstedt soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by wetness and the restricted rooting depth. Wetness generally limits the suitability of the unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are wetness and the slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Slow permeability and wetness increase the possibility of failure of septic tank absorption fields.

Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass IIe.

Figure 6.—Strawberries and boysenberries on Bornstedt silt loam, 0 to 8 percent slopes.

8C—Bornstedt silt loam, 8 to 15 percent slopes. This deep, moderately well drained soil is on high terraces and rolling uplands. It formed in mixed old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, hazel, and vine maple. Elevation is 400 to 650 feet. The average annual precipitation is about 48 to 65 inches, the average annual air temperature is 50 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is very dark brown silt loam about 8 inches thick. The upper 20 inches of the subsoil is reddish brown silty clay loam, and the lower 5 inches is brown and dark brown silty clay loam. Below this to a depth of 60 inches or more is brittle, reddish brown and reddish gray clay and variegated reddish brown and brown silty clay. Depth to the brittle layer ranges from 30 to 40 inches.

Included in this unit are small areas of Borges, Powell, Cazadero, and Jory soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Bornstedt soil is slow. Available water capacity is about 3 to 7 inches. Effective rooting depth is restricted by the brittle layer. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly nursery stock, strawberries, and raspberries. Among the other crops grown are small grain, potatoes, filberts, hay, and pasture. Some areas are used as homesites and wildlife habitat and for recreation.

This unit is suited to cultivated crops. It is limited mainly by wetness, the restricted rooting depth, and steepness of slope. Wetness generally limits the suitability of the soil in this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are wetness, the slow permeability, and steepness of slope. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Slow permeability and wetness increase the possibility of failure of septic tank absorption fields.

Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass IIIe.

8D—Bornstedt silt loam, 15 to 30 percent slopes. This deep, moderately well drained soil is on high terraces and rolling uplands. It formed in mixed old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, hazel, and vine maple. Elevation is 400 to 650 feet. The average annual precipitation is about 48 to 65 inches, the average annual air temperature is 50 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is very dark brown silt loam about 8 inches thick. The upper 20 inches of the subsoil is reddish brown silty clay loam, and the lower 5 inches is brown and dark brown silty clay loam. The substratum to a depth of 60 inches or more is brittle, reddish brown and reddish gray clay and variegated reddish brown and brown silty clay. Depth to the brittle layer ranges from 30 to 40 inches.

Included in this unit are small areas of Borges, Powell, Cazadero, and Jory soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Bornstedt soil is slow. Available water capacity is about 3 to 7 inches. Effective rooting depth is restricted by the brittle layer. Runoff is medium, and the hazard of water erosion is severe. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as strawberries, raspberries, nursery stock, hay, pasture, and potatoes. It is also used as homesites and wildlife habitat and for recreation.

If this unit is used for cultivated crops, it is limited mainly by wetness, the restricted rooting depth, and steepness of slope. All tillage should be on the contour or across the slope. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are steepness of slope, wetness, and the slow permeability. Drainage is needed if roads and buildings are constructed.

The steepness of slope is a concern in installing septic tank absorption fields. Slow permeability and wetness increase the possibility of failure of septic tank absorption fields.

Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass IVe.

9B—Bull Run silt loam, 3 to 8 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in silty material mixed with volcanic ash. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, western redcedar, red alder, swordfern, oxalis, and vine maple. Elevation is 500 to 2,000 feet. The average annual precipitation is about 60 to 95 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 180 days.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 30 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are small areas of Aschoff, Cazadero, Kinney, and Alspaugh soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Bull Run soil is moderate. Available water capacity is about 13 to 15 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate.

This unit is used mainly for timber production. It is also used for pasture, cultivated crops, homesites, wildlife habitat, and recreation. The main cultivated crop is red raspberries (fig. 7).

If this unit is used for pasture, the main limitations are a short growing season and cool temperatures. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed for optimum growth of grasses and legumes.

If this unit is used for cultivated crops, the main limitation is a short growing season. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. Grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur,

Figure 7.—Raspberries on Bull Run silt loam, 3 to 8 percent slopes. Mount Hood in background.

and lime; and berries respond to nitrogen, phosphorus, and potassium.

This unit is well suited to the production of Douglas-fir. It has few limitations. The site index for Douglas-fir ranges from 155 to 175. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Brushy plants such as red alder and vine maple limit natural regeneration of Douglas-fir.

This unit has few limitations for homesite development. Preserving the existing plant cover during construction helps to control erosion.

This map unit is in capability subclass IIIe.

9D—Bull Run silt loam, 8 to 30 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in silty material mixed with volcanic ash. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, western redcedar, red alder, swordfern, oxalis, and vine maple. Elevation is 500 to 2,000 feet. The average annual precipitation is about 60 to 95 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 180 days.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 30 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are small areas of Aschoff and Alspaugh soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Bull Run soil is moderate. Available water capacity is about 13 to 15 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe.

This unit is used mainly for timber production. It is also used for pasture, homesites, recreation, water supply, and wildlife habitat.

If this unit is used for pasture, the main limitations are steepness of slope, a short growing season, and cool temperatures. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed for optimum growth of grasses and legumes.

This unit is well suited to the production of Douglas-fir. It has few limitations. The site index for Douglas-fir ranges from 155 to 175. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Roads for year-round use need heavy base rock. Brushy plants such as red alder and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitation is steepness of slope. Preserving the existing plant cover during construction helps to control erosion. The steepness of slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass VIe.

9E—Bull Run silt loam, 30 to 60 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in silty material mixed with volcanic ash. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, western redcedar, red alder, swordfern, oxalis, and vine maple. Elevation is 500 to 2,000 feet. The average annual precipitation is about 60 to 95 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 180 days.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 30 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are small areas of Aschoff and Alspaugh soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Bull Run soil is moderate. Available water capacity is about 13 to 15 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, water supply, and recreation.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 155 to 175. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are steepness of slope and the hazard of erosion. Conventional methods of harvest are difficult to use because of the steepness of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during December through March. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Roads for year-round use need heavy base rock. Brushy plants such as red alder and vine maple limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

10C—Bull Run Variant silt loam, 0 to 12 percent slopes. This deep, somewhat poorly drained soil is in concave areas of rolling uplands. It formed in silty material that is high in content of volcanic ash. The native vegetation is mainly red alder, western redcedar, western hemlock, vine maple, salmonberry, and swordfern. Elevation is 500 to 1,500 feet. The average annual precipitation is 80 to 95 inches, the average annual air temperature is 48 to 50 degrees F, and the average frost-free period is 120 to 180 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 14 inches thick. The subsoil is dark brown and yellowish brown silt loam about 24 inches thick. The upper 10 inches of the substratum is yellowish brown silt loam, and the lower part to a depth of 60 inches or more is grayish brown silty clay loam.

Included in this unit are small areas of Bull Run and Aschoff soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Bull Run Variant soil is moderately slow. Available water capacity is about 9 to 12 inches.

Effective rooting depth is 20 to 30 inches. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 6 to 18 inches in winter and early in spring.

This unit is used for pasture, wildlife habitat, and homesites.

If this unit is used for hay and pasture, the main limitations are wetness and a short growing season. Wetness limits the choice of suitable plants and the period of cutting or grazing and increases the risk of winterkill. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

If this unit is used for homesite development, the main limitation is wetness. Drainage is needed if roads and buildings are constructed and for best results with most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens.

Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability.

This map unit is in capability subclass VIw.

11—Camas gravelly sandy loam. This deep, excessively drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly black cottonwood, bigleaf maple, Oregon ash, and blackberry. Elevation is 100 to 1,500 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown gravelly sandy loam about 10 inches thick. The upper 7 inches of the substratum is brown gravelly sandy loam, and the lower part to a depth of 60 inches or more is dark brown and brown, stratified extremely gravelly coarse sand and very gravelly loamy sand. Depth to the lower part of the substratum ranges from 12 to 20 inches.

Included in this unit are small areas of Newberg, McBee, Cloquato, Chehalis, and Wapato soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Camas soil is very rapid. Available water capacity is about 1.5 to 3.5 inches. Effective rooting depth is restricted by the lower part of the substratum. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to brief periods of flooding in winter.

This unit is used for pasture, hay, wildlife habitat, and recreation.

If this unit is used for hay and pasture, the main limitations are the hazard of flooding, droughtiness, and the content of rock fragments. Fertilizer is needed for optimum growth of grasses and legumes.

This map unit is in capability subclass IVw.

12A—Canderly sandy loam, 0 to 3 percent slopes. This deep, somewhat excessively drained soil is on terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, blackberries, grasses, and weeds. Elevation is 120 to 250 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown and very dark grayish brown sandy loam about 15 inches thick. The subsoil is dark brown and dark yellowish brown sandy loam about 31 inches thick. The substratum to a depth of 60 inches or more is stratified, dark yellowish brown loamy sand and coarse sandy loam.

Included in this unit are small areas of Latourell, Quatama, and Woodburn soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Canderly soil is moderately rapid. Available water capacity is about 5.5 to 7.5 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly nursery stock, berries, flowers, and filberts. Among the other crops grown are potatoes, corn, turnips, squash, tomatoes, and other vegetables. Some areas are used for homesite development, recreation, and wildlife habitat. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Canderly soils that have been cut or graded.

This unit is well suited to cultivated crops (fig. 8). It is limited mainly by droughtiness. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Because the soil in this unit is droughty, applications of irrigation water should be light and frequent. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to homesite development. It has few limitations. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If the density of housing is moderate to high, community sewage systems are needed to prevent

contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIe.

13B—Cascade silt loam, 3 to 8 percent slopes. This deep, somewhat poorly drained soil is on rolling uplands. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, vine maple, salal, swordfern, grasses, and forbs. Elevation is 250 to 1,400 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 11 inches thick. The subsoil is dark yellowish brown silt loam about 10 inches thick. Below this to a depth of 60 inches or more is a dark yellowish brown, mottled silt loam and silty clay loam hardpan. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Powell, Kinton, Cornelius, Delena, and Laurelwood soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 21 inches and slow below this depth. Available water capacity is about 5.0 to 7.5 inches. Effective rooting depth is restricted by the hardpan. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 18 to 30 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for pasture, hay, and small grain. It is also used for timber production, homesites, wildlife habitat, and recreation. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Cascade soils that have been cut or graded.

If this unit is used for pasture, hay, and small grain, the main limitations are wetness, restricted rooting depth, and droughtiness. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage systems are difficult to install because of the depth to the hardpan. They should be installed across the slope. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity and the water intake rate; overirrigating and leaching of plant nutrients should be avoided.

Excessive cultivation of the soil in this unit can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas fir ranges from 150 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber on this unit are wetness and restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Trees are subject to windthrow because of the restricted rooting depth. Roads need heavy base rock for year-round use. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness and low soil strength. Drainage should be provided if buildings with basements and crawl spaces are constructed. Wetness is reduced by installing drain tile around footings. The hardpan in this soil is rippable and therefore is not a serious limitation for most engineering uses. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall because of the hardpan.

Preserving the existing plant cover on this unit during construction helps to control erosion. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. It is difficult to establish these plants in areas that have had the surface layer and subsoil removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass IIIw.

13C—Cascade silt loam, 8 to 15 percent slopes. This deep, somewhat poorly drained soil is on rolling uplands. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, vine maple, salal, swordfern, grasses, and forbs. Elevation is 250 to 1,400 feet. The average annual precipitation is about 50 to 60 inches, the

Figure 8.—Canderly sandy loam, 0 to 3 percent slopes, is very friable and easily plowed.

contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIs.

12B—Canderly sandy loam, 3 to 8 percent slopes. This deep, somewhat excessively drained soil is on terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, blackberry, and grasses. Elevation is 120 to 250 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown and very dark grayish brown sandy loam about 15 inches thick. The subsoil is dark brown and dark yellowish brown sandy loam about 31 inches thick. The substratum to a depth of 60 inches or more is stratified, dark yellowish brown loamy sand and coarse sandy loam.

Included in this unit are small areas of Aloha and Latourell soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Canderly soil is moderately rapid. Available water capacity is about 5.5 to 7.5 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly nursery stock and vegetables. Among the other crops grown are pasture, hay, filberts, small grain, and berries. Some areas are used as homesites and wildlife habitat.

This unit is well suited to cultivated crops. It is limited mainly by droughtiness. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop.

This unit is suited to homesite development. It has few limitations. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If the density of housing is moderate to high, community sewage systems are needed to prevent

average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 11 inches thick. The subsoil is dark yellowish brown silt loam about 10 inches thick. Below this to a depth of 60 inches or more is a dark yellowish brown, mottled silt loam and silty clay loam hardpan. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Powell, Kinton, Cornelius, and Laurelwood soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 21 inches and slow below this depth. Available water capacity is about 5.0 to 7.5 inches. Effective rooting depth is restricted by the hardpan. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 18 to 30 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for pasture, hay, and small grain. It is also used for timber production, homesites, wildlife habitat, and recreation. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 24 inches of fill material or have had as much as 36 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Cascade soils that have been cut or graded.

If this unit is used for pasture, hay, and small grain, the main limitations are slope, wetness, restricted rooting depth, and droughtiness. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage systems are difficult to install because of the depth to the hardpan. They should be installed across the slope.

In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Excessive cultivation of the soil in this unit can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are wetness and the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Trees are subject to windthrow because of the restricted rooting depth. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness, low soil strength, and steepness of slope. Drainage should be provided if buildings with basements and crawl spaces are constructed. Wetness is reduced by installing drain tile around footings.

Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall because of the hardpan. The steepness of slope is a concern in installing septic tank absorption fields.

Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. It is difficult to establish these plants in areas that have had the surface layer and subsoil removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass IIIe.

13D—Cascade silt loam, 15 to 30 percent slopes. This deep, somewhat poorly drained soil is on rolling uplands. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, vine maple, salal, swordfern, grasses, and forbs. Elevation is 250 to 1,400 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 11 inches thick. The subsoil is dark yellowish brown silt loam about 10 inches thick. Below this to a depth of 60 inches or more is a dark yellowish brown, mottled silt loam and clay loam hardpan. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Kinton, Cornelius, Laurelwood, and Saum soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 21 inches and slow below this depth. Available water capacity is about 5.0 to 7.5 inches. Effective rooting depth is restricted by the hardpan. Runoff is medium, and the hazard of water erosion is severe. The water table is at a depth of 18 to 30 inches in winter and early in spring. This soil is droughty in summer.

This unit is used for hay and pasture, timber production, wildlife habitat, and recreation. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 24 inches of fill material or have had as much as 36 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Cascade soils that have been cut or graded.

If this unit is used for hay and pasture, the main limitations are steepness of slope, wetness, the restricted rooting depth, and droughtiness. All seedbed preparation should be done on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are steepness of slope, wetness, and the restricted rooting depth. The steepness of slope limits the kinds of equipment that can be used in forest management. Trees are subject to windthrow because of the restricted rooting depth. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are steepness of slope, wetness, and low soil strength. Excavation for roads and buildings increases the risk of erosion. Preserving the existing plant cover during construction helps to control erosion.

Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall because of the hardpan. The steepness of slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass IVe.

13E—Cascade silt loam, 30 to 60 percent slopes. This deep, somewhat poorly drained soil is on rolling uplands. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, vine maple, salal, swordfern, grasses, and forbs. Elevation is 250 to 1,400 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 11 inches thick. The subsoil is dark yellowish brown silt loam about 10 inches thick. Below this to a depth of 60 inches or more is a dark yellowish brown, mottled silt loam and clay loam hardpan. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Kinton, Cornelius, Laurelwood, and Saum soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 21 inches and slow below this depth. Available water capacity is about 5.0 to 7.5 inches. Effective rooting depth is restricted by the hardpan. Runoff is rapid, and the hazard of water erosion is severe. The water table is at a depth of 18 to 30 inches in winter and early in spring. This soil is droughty in summer.

This unit is used for timber production, wildlife habitat, homesite development, and recreation.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are steepness of slope, wetness, and the restricted rooting depth. Conventional methods of harvest are difficult to use because of the steepness of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during December through March. Trees are subject to windthrow because of the restricted rooting depth. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are steepness of slope, wetness, slow permeability, and low soil strength. Drainage is needed if roads and buildings are constructed. Wetness can be reduced by installing drain tile around footings.

Because of the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall. This unit generally is too steep to install septic tank absorption fields.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. It is difficult to establish plants in areas where the surface layer and subsoil have been removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass VIe.

14C—Cascade silt loam, stony substratum, 3 to 15 percent slopes. This deep, somewhat poorly drained soil is on rolling uplands. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, white oak, western hazel, vine maple, salal, and grasses. Elevation is 250 to 1,100 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 51 to 53 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 15 inches thick. The upper 9 inches of the subsoil is dark brown, mottled silt loam, and the lower 8 inches is a brown silt loam hardpan. The substratum to a depth of 60 inches or more is reddish brown very stony silty clay loam.

Included in this unit are small areas of Saum, Powell, Kinton, Cornelius, and Delena soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 24 inches, slow between depths of 24 and 32 inches, and moderately slow below a depth of 32 inches. Available water capacity is about 3.5 to 6.5 inches. Effective rooting depth is 20 to 30 inches. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 12 to 24 inches in winter and early in spring. This soil is droughty in summer.

This unit is used for timber production, crops such as pasture and small grain, homesites, and wildlife habitat. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Cascade soils that have been cut or graded.

If this unit is used for pasture, hay, and grain, the main limitations are wetness, shallow rooting depth, and droughtiness. The water table that develops during the rainy period in winter generally limits the suitability of this unit for deep-rooted crops. Tile drainage systems are difficult to install because of the depth to the hardpan. They should be installed across the slope. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most suitable method of applying water. Applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs to avoid overirrigating and leaching of plant nutrients.

Excessive cultivation of the soil in this unit can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. If the soil is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 135 to 150. On the basis of a site index of 140, the potential production per acre of merchantable timber is 8,700 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 77,280 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are the restricted rooting depth and wetness. Trees are subject to windthrow because of the restricted rooting depth. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness, the slow permeability, low soil strength, and large stones. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. The large stones in the substratum interfere with excavation for installing utilities. Because of the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. It is difficult to establish plants in areas where the upper part of the soil has been removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIIw.

14D—Cascade silt loam, stony substratum, 15 to 30 percent slopes. This deep, somewhat poorly drained soil is on rolling uplands. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, vine maple, salal, and grasses. Elevation is 250 to 1,100 feet. The average

annual precipitation is about 50 to 60 inches, the average annual air temperature is 51 to 53 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 15 inches thick. The upper 9 inches of the subsoil is dark brown, mottled silt loam, and the lower 8 inches is a brown silt loam hardpan. The substratum to a depth of 60 inches or more is reddish brown very stony silty clay loam.

Included in this unit are small areas of Saum, Powell, Kinton, and Cornelius soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 24 inches, slow between depths of 24 and 32 inches, and moderately slow below a depth of 32 inches. Available water capacity is about 7.5 to 9.0 inches. Effective rooting depth is 20 to 30 inches. Runoff is medium, and the hazard of water erosion is severe. The water table is at a depth of 12 to 24 inches in winter and early in spring. This soil is droughty in summer.

This unit is used for timber production and as homesites and wildlife habitat.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 135 to 150. On the basis of a site index of 140, the potential production per acre of merchantable timber is 8,700 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 77,280 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are the restricted rooting depth and wetness. Trees are subject to windthrow because of the restricted rooting depth. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness, the slow permeability, steepness of slope, low soil strength, and large stones. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. The large cobbles and stones in the substratum interfere with excavation for installing utilities.

Because of the depth to the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall. Slope is a concern in installing septic tank absorption fields.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. It is difficult to establish plants in areas where the upper part of the soil has been removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IVe.

14E—Cascade silt loam, stony substratum, 30 to 60 percent slopes. This deep, somewhat poorly drained soil is on rolling uplands. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, vine maple, salal, and grasses. Elevation is 250 to 1,100 feet. The average annual precipitation is about 50 to 60 inches, the average annual air temperature is 51 to 53 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 15 inches thick. The upper 9 inches of the subsoil is dark brown, mottled silt loam, and the lower 8 inches is a brown silt loam hardpan. The substratum to a depth of 60 inches or more is reddish brown very stony silty clay loam. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Saum, Powell, Kinton, and Cornelius soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cascade soil is moderate to a depth of 24 inches, slow between depths of 24 and 32 inches, and moderately slow below a depth of 32 inches. Available water capacity is about 3.5 to 6.5 inches. Effective rooting depth is restricted by the hardpan. Runoff is rapid, and the hazard of water erosion is severe. The water table is at a depth of 12 to 24 inches in winter and early in spring. This soil is droughty in summer.

This unit is used for timber production and as homesites and wildlife habitat.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 135 to 150. On the basis of a site index of 140, the potential production per acre of merchantable timber is 8,700 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 77,280 board feet (International rule, one-eighth inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are restricted rooting depth, wetness, and steepness of slope. Trees are subject to windthrow because of the restricted rooting depth. Conventional methods of harvesting timber are difficult to use because of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during December through March. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are steepness of slope, wetness, slow permeability, low soil strength, and large stones.

Drainage is needed if roads and buildings are constructed. Wetness can be reduced by installing drain tile around footings. The large cobbles and stones that are in the substratum interfere with excavation for installing utilities.

Because of the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall. This unit generally is too steep to install septic tank absorption fields.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. It is difficult to establish plants in areas where the upper part of the soil has been removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass VIe.

15B—Cazadero silty clay loam, 0 to 7 percent slopes. This deep, well drained soil is on high terraces. It formed in old mixed alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, western hazel, and vine maple. Elevation is 600 to 900 feet. The average annual precipitation is about 60 to 85 inches, the average annual air temperature is 50 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark reddish brown silty clay loam about 12 inches thick. The upper 9 inches of the subsoil is yellowish red silty clay loam, and the lower 20 inches is yellowish red silty clay and clay. Below this to a depth of 60 inches or more is dark red and dark reddish brown clay.

Included in this unit are small areas of Cottrell, Alspaugh, Bornstedt, and Borges soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cazadero soil is moderately slow. Available water capacity is about 7.5 to 9.0 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used for crops, mainly nursery stock, strawberries, and raspberries. Among the other crops grown are grass seed, small grain, hay, and pasture. Some areas are used as homesites, timber production, wildlife habitat, and recreation. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 75 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Cazadero soils that have been cut or graded.

This unit is suited to cultivated crops. It has few limitations. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling can be used to break up the tillage pan. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the susceptibility of the soil to compaction. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the moderately slow permeability and low soil strength. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. If the unit is used for septic tank absorption fields, the limitation of moderately slow permeability can be overcome by increasing the size of the absorption field.

Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

15C—Cazadero silty clay loam, 7 to 12 percent slopes. This deep, well drained soil is on high terraces. It formed in old mixed alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, western hazel, and vine maple. Elevation is 600 to 900 feet. The average annual precipitation is about 60 to 85

inches, the average annual air temperature is 50 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark reddish brown silty clay loam about 12 inches thick. The upper 9 inches of the subsoil is yellowish red silty clay loam, and the lower 20 inches is yellowish red silty clay and clay. Below this to a depth of 60 inches or more is dark red clay.

Included in this unit are small areas of Alspaugh, Cottrell, and Bornstedt soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Cazadero soil is moderately slow. Available water capacity is about 7.5 to 9.0 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

Most areas of this unit are used for crops, mainly nursery stock, strawberries, and raspberries. Among the other crops grown are grass seed, small grain, hay, and pasture. Some areas are used for timber production, homesites, wildlife habitat, and recreation.

This unit is suited to cultivated crops. It is limited mainly by steepness of slope. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling can be used to break up the tillage pan. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are the hazard of erosion and the susceptibility of the soil to compaction. Conventional methods of harvesting timber generally are suitable. but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are steepness of slope, the moderately slow permeability, and low soil strength. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. If the unit is used for septic tank absorption fields, the limitation of moderately slow permeability can be overcome by increasing the size of the absorption field.

Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

15D—Cazadero silty clay loam, 12 to 20 percent slopes. This deep, well drained soil is on high terraces. It formed in old mixed alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, western hazel, and vine maple. Elevation is 600 to 900 feet. The average annual precipitation is about 60 to 85 inches, the average annual air temperature is 50 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark reddish brown silty clay loam about 12 inches thick. The upper 9 inches of the subsoil is yellowish red silty clay loam, and the lower 20 inches is yellowish red silty clay and clay. Below this to a depth of 60 inches or more is dark red clay.

Included in this unit are small areas of Alspaugh, Cottrell, and Bornstedt soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Cazadero soil is moderately slow. Available water capacity is about 7.5 to 9.0 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly for timber production, hay, and pasture. It is also used for cultivated crops such as grass seed and as homesites, wildlife habitat, and recreation.

This unit is suited to cultivated crops. It is limited mainly by steepness of slope. All tillage should be on the contour or across the slope. A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling can be used to break up the tillage pan.

When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International

rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are the susceptibility of the soil to compaction, the hazard of erosion, and steepness of slope. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Brushy plants such as western hazel and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the moderately slow permeability, steepness of slope, and low soil strength.

If this unit is used for septic tank absorption fields, the limitation of moderately slow permeability can be overcome by increasing the size of the absorption field. The steepness of slope is a concern in installing septic tank absorption fields. Excavation for roads and buildings increases the risk of erosion. Preserving the existing plant cover during construction helps to control erosion. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

This map unit is in capability subclass IVe.

16—Chehalis silt loam. This deep, well drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, ash, Oregon white oak, blackberry, shrubs, and grasses. Elevation is 50 to 350 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam and silty clay loam about 24 inches thick. The subsoil is dark brown silty clay loam about 20 inches thick. The substratum to a depth of 60 inches or more is stratified, dark yellowish brown silty clay loam and fine sandy loam. In some areas very gravelly sand is below a depth of 40 inches.

Included in this unit are small areas of McBee, Cloquato, Newberg, Wapato, and Camas soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Chehalis soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. This soil is subject to occasional, brief periods of flooding in winter. This soil is droughty in summer.

Most areas of this unit are used for cultivated crops, mainly sweet corn, bush beans, winter wheat, and alfalfa. Among the other crops grown are strawberries, filberts, and potatoes. Some areas are used as wildlife habitat and for timber production and recreation.

This unit is suited to annual and perennial crops that can withstand occasional periods of flooding. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling can be used to break up the tillage pan. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 125 to 135. On the basis of a site index of 130, the potential production per acre of merchantable timber is 7,740 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 75,690 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are the occasional periods of flooding in winter, susceptibility of the surface layer to compaction, and brush competition. Seedling mortality is a concern because of the periods of flooding. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as trailing blackberry and Oregon ash limit natural regeneration of Douglas-fir.

This map unit is in capability subclass IIw.

17—Clackamas silt loam. This deep, somewhat poorly drained soil is on low terraces. It formed in gravelly mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Oregon ash, ponderosa pine, rose, and grasses. Elevation is 175 to 700 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown silt loam about 7 inches thick. The upper 13 inches of the subsoil is very dark grayish brown and dark grayish brown silty clay loam, and the lower 16 inches is dark grayish brown gravelly silty clay loam. The substratum to a depth of 60 inches or more is variegated, dark brown and strong brown extremely gravelly silty clay loam. Depth to the

extremely gravelly substratum ranges from 24 to 36 inches.

Included in this unit are small areas of Salem, Coburg, and Conser soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Clackamas soil is moderately slow. Available water capacity is about 3.0 to 7.5 inches. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 6 to 18 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for hay and pasture. It is also used for cultivated crops such as small grain, grass seed, and vegetables and as homesites, wildlife habitat, and recreation.

This unit is suited to cultivated crops. It is limited mainly by wetness and the restricted rooting depth. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitations are wetness and the moderately slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods.

In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass IIw.

18—Clackamas gravelly loam. This deep, somewhat poorly drained soil is on low terraces. It formed in mixed gravelly alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Oregon ash, western hazel, rose, and grasses. Elevation is 100 to 400 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 200 days.

Typically, the surface layer is very dark brown and very dark grayish brown gravelly loam about 7 inches thick. The subsoil is mottled, very dark gray clay loam about 4 inches thick. The substratum to a depth of 60 inches or more is variegated, dark brown extremely gravelly clay loam. Depth to the extremely gravelly substratum ranges from 11 to 24 inches.

Included in this unit are small areas of Salem, Coburg, and Conser soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Clackamas soil is moderately slow. Available water capacity is about 3 to 5 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 6 to 18 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for pasture and hay. It is also used for cultivated crops such as small grain and as homesites, wildlife habitat, and recreation.

This unit is suited to cultivated crops. It is limited mainly by wetness. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitations are wetness and the moderately slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods.

In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIIw.

19—Cloquato silt loam. This deep, well drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, black cottonwood, Oregon white oak, bigleaf maple, blackberry, shrubs, and grasses. Elevation is 50 to 300 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 15 inches thick. The subsoil is dark brown silt loam about 27 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown sandy loam.

Included in this unit are small areas of Chehalis, McBee, Newberg, and Wapato soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cloquato soil is moderate. Available water capacity is about 9 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. This soil is subject to occasional, brief periods of flooding in winter. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly sweet corn and bush beans. Among the other crops grown are winter wheat, filberts, strawberries, alfalfa, and peaches. Some areas are used as wildlife habitat and for timber production and recreation.

This unit is suited to annual and perennial crops that can withstand occasional periods of flooding. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If the soil in this unit is plowed in fall, erosion is reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 120 to 130. On the basis of a site index of 125, the potential production per acre of merchantable timber is 7,320 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 69,840 board feet (International rule, one-eighth-inch kerf) from an even-aged fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are the occasional periods of flooding, susceptibility of the surface layer to compaction, and brush competition. Seedling mortality is a concern because of the periods of flooding. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as trailing blackberry and Oregon ash limit natural regeneration of Douglas-fir.

This map unit is in capability subclass IIw.

20—Coburg silty clay loam. This deep, moderately well drained soil is on stream terraces. It formed in mixed silty and clayey alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, poison-oak, blackberry, shrubs, and grasses. Elevation is 150 to 1,000 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silty clay loam about 20 inches thick. The upper 10 inches of the subsoil is very dark grayish brown and dark brown silty clay loam, and the lower 6 inches is brown silty clay. The substratum to a depth of 60 inches or more is brown silty clay loam.

Included in this unit are small areas of Conser, Malabon, Clackamas, Salem, and Cove soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Coburg soil is moderately slow. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 18 to 30 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as wheat, vegetables, hay, and pasture. Grass seed is grown in some areas. Some areas of the unit are used for recreation and as homesites and wildlife habitat.

This unit is well suited to cultivated crops. It is limited mainly by wetness. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling breaks up the tillage pan. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitations are wetness, the moderately slow permeability, and low soil strength. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIw.

21—Concord silt loam. This deep, poorly drained soil is on broad terraces. It formed in stratified glaciolacustrine deposits. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly grasses, sedges, rushes, wild rose, wild blackberry, Oregon ash, Oregon white oak, and western hazel. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown silt loam about 6 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 14 inches thick. The upper 8 inches of the subsoil is brown silty clay loam, and the lower 8 inches is grayish brown silty clay. The substratum to a depth of 60 inches or more is grayish brown silty clay loam.

Included in this unit are small areas of Dayton, Amity, Huberly, and Aloha soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Concord soil is slow. Available water capacity is about 9 to 11 inches. Effective rooting depth is 20 to 28 inches. Runoff is slow to ponded, and the hazard of water erosion is slight. The water table is 6 inches above the surface to 6 inches below the surface in winter and early in spring.

This unit is used mainly for crops such as small grain, pasture, hay, and grass seed. Other crops grown are corn and beans. Some areas of the unit are used as homesites and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by wetness and the slow permeability. Tile drainage can be used to reduce wetness if a suitable outlet is available. Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitations are wetness, slow permeability, and a potential for shrinking and swelling. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the effects of shrinking and swelling. Septic tank absorption fields do not function properly during rainy periods because of wetness and the slow permeability.

This map unit is in capability subclass IIIw.

22—Conser silty clay loam. This deep, poorly drained soil is on stream terraces. It formed in mixed silty and clayey alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Oregon ash, Oregon white oak, hawthorn, rose, sedges, rushes, and grasses. Elevation is 150 to 500 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The upper 27 inches of the subsoil is very dark gray silty clay loam, and the lower 14 inches is dark gray silty clay. The substratum to a depth of 60 inches or more is brown loam. In some areas the lower part of the substratum is very gravelly loam.

Included in this unit are small areas of Coburg, Clackamas, Malabon, and Cove soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Conser soil is slow. Available water capacity is about 9 to 11 inches. Effective rooting depth is 14 to 27 inches. Runoff is slow to ponded, and the hazard of water erosion is slight. The water table is at a depth of 0 to 18 inches in winter and early in spring.

This unit is used mainly for crops such as grass seed, hay, and pasture. Other crops grown are vegetables and spring grain. Some areas of the unit are used as homesites and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by wetness and restricted rooting depth. Wetness generally limits the suitability of the soil for deep-rooted crops. Drainage is difficult because of the slow permeability. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling breaks up the tillage pan. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer and poor tilth. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitations are wetness, the slow permeability, a potential for shrinking and swelling, and low soil strength. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be

designed to offset the effects of shrinking and swelling and to offset the limited ability of the soil in this unit to support a load. Septic tank absorption fields do not function properly during rainy periods because of wetness and the slow permeability.

This map unit is in capability subclass IIIw.

23B—Cornelius silt loam, 3 to 8 percent slopes. This deep, moderately well drained soil is on rolling uplands. It formed in silty material. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, western hazel, shrubs, and grasses. Elevation is 350 to 800 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 9 inches thick. The upper 7 inches of the subsoil is brown silt loam, and the lower 18 inches is dark yellowish brown silty clay loam. Below this to a depth of 60 inches or more is a dark yellowish brown and yellowish brown, mottled silt loam hardpan. Depth to the hardpan ranges from 30 to 40 inches.

Included in this unit are small areas of Kinton, Cascade, Delena, and Laurelwood soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cornelius soil is moderate to a depth of 34 inches and slow below this depth. Available water capacity is about 6 to 8 inches. Effective rooting depth is restricted by the hardpan. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 30 to 40 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as berries, hay, pasture, orchard crops, and nursery stock. It is also used for timber production, homesite development, wildlife habitat, and recreation. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Cornelius soils that have been cut or graded.

If this unit is used for cultivated crops, the main limitations are wetness and restricted rooting depth. Wetness generally limits the suitability of this unit for deep-rooted crops. Most climatically adapted crops can be grown if drainage is provided. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation of the soil in this unit can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are wetness and the restricted rooting depth. Trees are subject to windthrow because of the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness, low soil strength, and the slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness and the slow permeability.

Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

23C—Cornelius silt loam, 8 to 15 percent slopes. This deep, moderately well drained soil is on rolling uplands. It formed in silty material overlying old silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, western hazel, shrubs, and grasses. Elevation is 350 to 800 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 9 inches thick. The upper 7 inches of the subsoil is brown silt loam, and the lower

18 inches is dark yellowish brown silty clay loam. Below this to a depth of 60 inches or more is a dark yellowish brown and yellowish brown, mottled silt loam hardpan. Depth to the hardpan ranges from 30 to 40 inches.

Included in this unit are small areas of Kinton, Cascade, Delena, and Laurelwood soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Cornelius soil is moderate to a depth of 34 inches and slow below this depth. Available water capacity is about 6 to 8 inches. Effective rooting depth is restricted by the hardpan. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 30 to 40 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for cultivated crops, hay, and pasture. It is also used for timber production, wildlife habitat, homesites, and recreation. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 24 inches of fill material or have had as much as 36 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Cornelius soils that have been cut or graded.

If this unit is used for cultivated crops, the main limitations are slope, wetness, and restricted rooting depth. Wetness generally limits the suitability of this unit for deep-rooted crops. Most climatically adapted crops can be grown if drainage is provided. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Excessive cultivation of the soil can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are wetness and restricted rooting depth. Trees are subject to windthrow because of the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness, low soil strength, and steepness of slope. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness and the slow permeability.

Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

23D—Cornelius silt loam, 15 to 30 percent slopes. This deep, moderately well drained soil is on rolling uplands. It formed in silty material overlying old silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, western hazel, shrubs, and grasses. Elevation is 350 to 800 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 9 inches thick. The upper 7 inches of the subsoil is brown silt loam, and the lower 18 inches is dark yellowish brown silty clay loam. Below this to a depth of 60 inches or more is a dark yellowish brown and yellowish brown, mottled silt loam hardpan. Depth to the hardpan ranges from 30 to 40 inches.

Included in this unit are small areas of Kinton, Cascade, and Laurelwood soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Cornelius soil is moderate to a depth of 34 inches and slow below this depth. Available water capacity is about 6 to 8 inches. Effective rooting depth is restricted by the hardpan. Runoff is medium, and the hazard of water erosion is severe. The water table is at a depth of 30 to 40 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for timber production. It is also used for hay and pasture, homesites, wildlife habitat, and recreation.

If this unit is used for hay and pasture, the main limitations are steepness of slope, wetness, and restricted rooting depth. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. All tillage should be on the contour or across the slope.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are steepness of slope, wetness, and restricted rooting depth. Trees are subject to windthrow because of the restricted rooting depth. The steepness of slope limits the kinds of equipment that can be used in forest management. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are steepness of slope, wetness, low soil strength, and slow permeability. Excavation for roads and buildings increases the risk of erosion. Preserving the existing plant cover during construction helps to control erosion. The steepness of slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass IVe.

24B—Cottrell silty clay loam, 2 to 8 percent slopes. This deep, moderately well drained soil is on high terraces and rolling uplands. It formed in old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, red alder, western redcedar, salal, Oregon-grape, and blackberry. Elevation is 600 to 900 feet. The average annual precipitation is 45 to 80 inches, the average annual air temperature is 50 to 53 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is very dark grayish brown and dark brown silty clay loam about 12 inches thick. The upper 12 inches of the subsoil is dark brown silty clay loam, and the lower 31 inches is mottled, dark brown silty clay. The substratum to a depth of 60 inches or more is reddish brown silty clay loam.

Included in this unit are small areas of Borges, Jory, and Cazadero soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Cottrell soil is moderately slow. Available water capacity is about 7 to 12 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring.

This unit is used mainly for crops such as hay, pasture, small grain, and berries. Nursery stock is also grown. Some areas of the unit are used for timber production and as homesites and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by wetness. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling breaks up the tillage pan. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 155 to 170. On the basis of a site index of 160, the potential production per acre of merchantable timber is 10,200 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 95,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is wetness. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and red alder limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness, the moderately slow permeability, and low soil strength. Drainage is needed if roads and buildings are constructed. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability.

This map unit is in capability subclass IIIw.

24C—Cottrell silty clay loam, 8 to 15 percent slopes. This deep, moderately well drained soil is on high terraces and rolling uplands. It formed in mixed old alluvium. The vegetation in areas not cultivated is mainly

Douglas-fir, red alder, western redcedar, salal, Oregon-grape, and blackberry. Elevation is 600 to 900 feet. The average annual precipitation is 45 to 80 inches, the average annual air temperature is 50 to 53 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is very dark grayish brown and dark brown silty clay loam about 12 inches thick. The upper 12 inches of the subsoil is dark brown silty clay loam, and the lower 31 inches is mottled, dark brown silty clay. The substratum to a depth of 60 inches or more is reddish brown silty clay loam.

Included in this unit are small areas of Jory, Cazadero, and Borges soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cottrell soil is moderately slow. Available water capacity is about 7 to 12 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 24 to 36 inches in winter and early in spring.

This unit is used mainly for crops such as hay, pasture, small grain, and berries. Nursery stock is also grown. Some areas of the unit are used for timber production and as homesites and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by wetness and steepness of slope. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling breaks up the tillage pan. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 155 to 170. On the basis of a site index of 160, the potential production per acre of merchantable timber is 10,200 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 95,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is wetness. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and red alder limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness, the moderately slow permeability, and low soil strength. Drainage is needed if roads and buildings are constructed. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion.

Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability.

This map unit is in capability subclass IIIe.

24D—Cottrell silty clay loam, 15 to 30 percent slopes. This deep, moderately well drained soil is on high terraces and rolling uplands. It formed in old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, red alder, western redcedar, salal, Oregon-grape, and blackberry. Elevation is 600 to 900 feet. The average annual precipitation is 45 to 80 inches, the average annual air temperature is 50 to 53 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is very dark grayish brown and dark brown silty clay loam about 12 inches thick. The upper 12 inches of the subsoil is dark brown silty clay loam, and the lower 31 inches is mottled, dark brown silty clay. The substratum to a depth of 60 inches or more is reddish brown silty clay loam.

Included in this unit are small areas of Cazadero, Jory, and Borges soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cottrell soil is moderately slow. Available water capacity is about 7 to 12 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 24 to 36 inches in winter and early in spring.

This unit is used for hay, pasture, and timber production and as homesites and wildlife habitat.

If this unit is used for hay and pasture, the main limitations are wetness and steepness of slope. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. All tillage should be on the contour or across the slope.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 155 to 170. On the basis of a site index of 160, the potential production per acre of merchantable timber is 10,200 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 95,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are wetness and steepness of slope. Conventional

methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and red alder limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are steepness of slope, wetness, the moderately slow permeability, and low soil strength. Wetness is reduced by installing drain tile around footings. The hazard of erosion is increased if the soil is left exposed during site development. Preserving the existing plant cover during construction helps to control erosion. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability.

This map unit is in capability subclass IVe.

25—Cove silty clay loam. This deep, poorly drained soil is on flood plains. It formed in clayey alluvium. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly Oregon ash, willows, sedges, blackberries, and grasses. Elevation is 100 to 1,500 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsoil is black and very dark gray silty clay about 36 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown silty clay.

Included in this unit are small areas of Wapato, Conser, Coburg, Concord, and Dayton soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Cove soil is very slow. Available water capacity is about 4.0 to 4.5 inches. Effective rooting depth is limited by the water table that is at a depth of 0 to 24 inches from December to April. Runoff is slow to ponded, and the hazard of water erosion is slight.

This unit is used mainly for pasture and hay. Some vegetables are also grown. Some areas of the unit are used as wildlife habitat and homesites.

This unit is suited to cultivated crops. It is limited mainly by wetness and the very slow permeability. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables respond to nitrogen, phosphorus, and potassium. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer and poor tilth.

If this unit is used for homesite development, the main limitations are wetness, the very slow permeability, a potential for shrinking and swelling, and low soil strength. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling.

Septic tank absorption fields do not function properly during rainy periods because of wetness and the very slow permeability.

This map unit is in capability subclass IVw.

26B—Crutch cobbly loamy coarse sand, 0 to 5 percent slopes. This deep, moderately well drained soil is on stream terraces. It formed in glacial outwash derived dominantly from andesite and basalt. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, western redcedar, red alder, salal, and oxalis. Elevation is 500 to 2,000 feet. The average annual precipitation is about 80 to 95 inches, the average annual air temperature is 46 to 50 degrees F, and the average frost-free period is 80 to 130 days.

Typically, the surface layer is dark gray cobbly loamy coarse sand about 2 inches thick. The subsoil is dark brown and brown cobbly loamy coarse sand and very cobbly loamy coarse sand about 26 inches thick. The substratum to a depth of 60 inches or more is weakly consolidated extremely cobbly loamy coarse sand. Depth to the weakly consolidated substratum ranges from 24 to 36 inches.

Included in this unit are small areas of Multorpor, Jimbo, and Bull Run soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Crutch soil is moderately rapid to a depth of 28 inches and slow below this depth. Available water capacity is about 1 to 2 inches. Effective rooting depth is restricted by the weakly consolidated substratum. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 18 to 30 inches in winter and early in spring. This soil is droughty in summer.

This unit is used as homesites, recreation, wildlife habitat, and timber production.

This unit is poorly suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 90 to 120. On the basis of a site index of 100, the potential production per acre of merchantable timber is 5,040 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 46,700 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

The main concerns in producing and harvesting timber are wetness, droughtiness, the restricted rooting depth,

and the content of coarse fragments. Trees commonly are subject to windthrow because the soil is saturated in winter and early in spring and because root growth is limited by the weakly consolidated substratum. The low available water capacity generally influences seedling survival in areas where understory plants are numerous. Brushy plants such as red alder and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness and the content of coarse fragments. Drainage should be provided if buildings with basements and crawl spaces are constructed. The weakly consolidated substratum is rippable and therefore is not a serious limitation for most engineering uses. Because of this restrictive layer, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

Plans for homesite development should provide for the preservation of as many trees as possible. It is difficult to establish plants in areas that have had the upper part of the soil removed, exposing the substratum. Mulch and fertilizer help to establish plants in cut areas. Removal of gravel and cobbles in disturbed areas is required for best results when landscaping, particularly in areas used for lawns. Plants that tolerate wetness and droughtiness should be selected if drainage and irrigation are not provided.

This map unit is in capability subclass VIs.

27—Crutch Variant loamy coarse sand, 0 to 3 percent slopes. This deep, poorly drained soil is on stream terraces. It formed in sandy glacial outwash. The vegetation in areas not cultivated is mainly red alder, western redcedar, western hemlock, salmonberry, swordfern, and sedges. Elevation is 500 to 2,000 feet. The average annual precipitation is about 80 to 95 inches, the average annual air temperature is 46 to 50 degrees F, and the average frost-free period is 80 to 130 days.

Typically, the surface layer is dark grayish brown loamy coarse sand about 4 inches thick. The subsurface layer is gray gravelly loamy coarse sand about 5 inches thick. The subsoil is dark brown and gray very gravelly loamy coarse sand and very cobbly loamy coarse sand about 15 inches thick. The substratum to a depth of 60 inches or more is grayish brown, weakly consolidated extremely cobbly coarse sand. Depth to the substratum ranges from 15 to 24 inches.

Included in this unit are small areas of Multorpor and Jimbo soils and Crutch cobbly loamy coarse sand. Included areas make up about 20 percent of the total acreage.

Permeability of this Crutch soil is moderate to a depth of 24 inches and slow below this depth. Available water capacity is about 2.5 to 4.0 inches. Effective rooting depth is restricted by the weakly consolidated substratum. Runoff is slow, and the hazard of water erosion is slight. The water table is 6 inches above the surface to 6 inches below the surface in winter and spring.

This unit is used as homesites and wildlife habitat and for recreation.

If this unit is used for homesite development, the main limitations are wetness and the weakly consolidated substratum. Drainage is needed if roads and buildings are constructed. Excess water can be removed by using shallow ditches and providing the proper grade.

Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall because of the weakly consolidated substratum.

This map unit is in capability subclass VIw.

28—Dabney loamy sand. This deep, somewhat excessively drained soil is on stream terraces. It formed in sandy alluvium derived dominantly from andesite. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, bigleaf maple, red alder, and shrubs. Elevation is 50 to 400 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is 50 to 52 degrees F, and the average frost-free period is 100 to 200 days.

Typically, the surface layer is very dark grayish brown loamy sand about 5 inches thick. The subsoil is dark grayish brown cobbly loamy sand about 13 inches thick. The substratum to a depth of 60 inches or more is dark gray and dark grayish brown gravelly coarse sand and gravelly sand. In some areas the substratum is cobbly sand.

Included in this unit are small areas of Multorpor, Camas, Crutch, and Jimbo soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Dabney soil is rapid. Available water capacity is about 3 to 4 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used for recreation and as wildlife habitat and homesites.

This unit is suited to homesite development. The main limitations are the rapid permeability and droughtiness. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass VIs.

29—Dayton silt loam. This deep, poorly drained soil is on broad terraces. It formed in stratified glaciolacustrine deposits. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly Oregon ash, hawthorn, rose, and native grasses. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 50

inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and brown silt loam and silty clay loam about 15 inches thick. The subsurface layer is light brownish gray silty clay loam about 6 inches thick. The subsoil is dark grayish brown clay about 24 inches thick. The substratum to a depth of 60 inches or more is dark brown clay. Depth to the clay subsoil ranges from 12 to 24 inches.

Included in this unit are small areas of Amity, Concord, and Huberly soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Dayton soil is very slow. Available water capacity is about 5 to 7 inches. Effective rooting depth is 12 to 24 inches. Runoff is slow to ponded, and the hazard of water erosion is slight. The water table is 6 inches above the surface to 18 inches below the surface in winter and early in spring.

This unit is used mainly for pasture and hay. Spring grain is also grown. Some areas of the unit are used as wildlife habitat and homesites.

This unit is suited to cultivated crops. It is limited mainly by wetness and the very slow permeability. Diversions and grassed waterways may be needed. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

If this unit is used for homesite development, the main limitations are the very slow permeability, wetness, a potential for shrinking and swelling, and low soil strength. Drainage is needed if roads and buildings are constructed. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling.

Septic tank absorption fields do not function properly during rainy periods because of wetness and the very slow permeability.

This map unit is in capability subclass IVw.

30C—Delena silt loam, 3 to 12 percent slopes. This deep, poorly drained soil is on high terraces and rolling uplands. It formed in silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, ash, snowberry, rose, trailing blackberry, sedges, and grasses. Elevation is 250 to 1,400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 12 inches thick. The upper 13 inches of the subsoil is dark grayish brown and grayish brown silty clay loam, and the lower 35 inches is a grayish brown, dark grayish brown, and yellowish red cemented silty clay loam hardpan. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Borges, Powell, Cascade, and Bornstedt soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Delena soil is moderate to a depth of 25 inches and very slow below this depth. Available water capacity is about 3 to 5 inches. Effective rooting depth is 12 to 24 inches. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 0 to 18 inches in winter and early in spring. This soil is droughty in summer.

This unit is used for pasture and as wildlife habitat and homesites.

If this unit is used for pasture, the main limitation is steepness of slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are wetness, the very slow permeability, and low soil strength. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Because of the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

It is difficult to establish plants in areas where the upper part of the soil has been removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IVw.

31F—Dystrochrepts, very steep. These deep, well drained soils are on terrace escarpments. They formed in colluvium derived dominantly from basalt and andesite. Slope is 35 to 80 percent. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, bigleaf maple, vine maple, red alder, salal, Oregon-grape, and swordfern. Elevation is 150 to 2,000 feet. The average annual precipitation is 55 to 95 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

No single profile is typical of Dystrochrepts, but one commonly observed in the survey area has a surface layer of dark brown gravelly loam or loam about 8 inches thick. The subsoil is brown gravelly loam or very gravelly loam about 36 inches thick. Depth to bedrock is 40 to 60 inches or more. In some areas of similar included soils, the surface layer is silt loam.

Included in this unit are small areas of Aschoff, Alspaugh, and Bull Run soils. Included areas make up about 20 percent of the total acreage.

Permeability of these Dystrochrepts is moderately slow to moderately rapid. Available water capacity is about 5 to 10 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 160. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are steepness of slope and the instability of the soil. Conventional methods of harvesting timber are difficult to use because of slope. Highlead logging or other logging methods that fully or partially suspend logs reduce the disturbance of the soil. Severe erosion or gullying can occur where the soil is disturbed. Landsliding and slumping can result where roads are constructed. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and red alder limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIIe.

32D—Fernwood very gravelly loam, 5 to 30 percent slopes. This moderately deep, well drained soil is on mountainous uplands. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. The native vegetation is mainly Douglas-fir, western hemlock, vine maple, Oregon-grape, salal, red huckleberry, swordfern, and brackenfern. Elevation is 1,800 to 3,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 110 days.

Typically, the surface layer is very dark grayish brown very gravelly loam about 10 inches thick. The subsoil is dark brown very cobbly loam about 15 inches thick. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are small areas of Zygore, Wilhoit, and Memaloose soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Fernwood soil is moderately rapid. Available water capacity is about 2 to 6 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 100 to 130. On the basis of a site index of 115, the potential production per acre of merchantable timber is 6,360 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 57,960 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are the restricted rooting depth and the content of coarse fragments. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Logging may be restricted during December through March because of snow accumulation. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIs.

32E—Fernwood very gravelly loam, 30 to 60 percent slopes. This moderately deep, well drained soil is on mountainous uplands. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. The native vegetation is mainly Douglas-fir, western hemlock, vine maple, Oregon-grape, salal, red huckleberry, swordfern, and brackenfern. Elevation is 1,800 to 3,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 110 days.

Typically, the surface layer is very dark grayish brown very gravelly loam about 10 inches thick. The subsoil is dark brown very cobbly loam about 15 inches thick. Bedrock is at a depth of 25 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are small areas of Zygore, Wilhoit, and Memaloose soils and Rock outcrop. Included areas make up about 20 percent of the total acreage.

Permeability of this Fernwood soil is moderately rapid. Available water capacity is about 2 to 6 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 100 to 130. On the basis of a site index of 115, the potential production per acre of merchantable timber is 6,360 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 57,960 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are steepness of slope, the restricted rooting depth, and the content of rock fragments. Conventional methods of harvesting timber are difficult to use because of slope. Highlead or other cable logging methods can be used. Logging may be restricted during December through March because of a deep accumulation of snow. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIs.

33F—Fernwood-Rock outcrop complex, 50 to 90 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly Douglas-fir, western hemlock, vine maple, Oregon-grape, salal, red huckleberry, swordfern, and brackenfern. Elevation is 1,800 to 3,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 110 days.

This unit is 60 percent Fernwood very gravelly loam and 20 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of soils that are similar to this Fernwood soil but are shallow to bedrock and small areas of Zygore and Wilhoit soils. Included areas make up about 20 percent of the total acreage.

The Fernwood soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is very dark grayish brown very gravelly loam about 10 inches thick. The subsoil is dark brown very cobbly loam about 15 inches thick. Bedrock is at a depth of 25 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Fernwood soil is moderately rapid. Available water capacity is about 2 to 6 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of basalt and andesite. Some areas are nearly perpendicular cliffs as much as 100 feet high. Other areas are columns as much as 150 feet in diameter and 100 feet high. Rock outcrop supports vegetation only where soil material has accumulated in pockets or fractures in the rock.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is poorly suited to the production of Douglas-fir. On the Fernwood soil, the site index for Douglas-fir ranges from 100 to 130. On the basis of a site index of 115, the potential production per acre of merchantable timber is 6,360 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 57,960 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are the steepness of slope, the areas of Rock outcrop, and the restricted rooting depth. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead logging or other logging methods that fully or partially suspend logs reduce the disturbance of the soil. Severe erosion or gullying can occur where the soil is disturbed. Logging may be restricted during December through March because of a deep accumulation of snow. The areas of Rock outcrop make felling and yarding difficult. Landsliding and slumping can result where roads are constructed.

Droughtiness caused by coarse fragments in the soil reduces seedling survival. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIIs.

34D—Fernwood-Wilhoit complex, 5 to 30 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly Douglas-fir, western hemlock, vine maple, Oregon-grape, salal, red huckleberry, swordfern, and brackenfern. Elevation is 1,800 to 3,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 110 days.

This unit is 45 percent Fernwood very gravelly loam and 40 percent Wilhoit gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Memaloose and Zygore soils and soils that are similar to this Fernwood soil but are less than 20 inches deep to bedrock. Included areas make up about 15 percent of the total acreage.

The Fernwood soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is very dark grayish brown very gravelly loam about 10 inches thick. The subsoil is dark brown very cobbly loam about 15 inches thick. Bedrock is at a depth of 25 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Fernwood soil is moderately rapid. Available water capacity is about 2 to 6 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is medium, and the hazard of water erosion is moderate.

The Wilhoit soil is deep and well drained. It formed in colluvium derived from andesite, tuff, and breccia mixed with volcanic ash. Typically, the surface layer is very dark grayish brown gravelly loam and loam about 15

inches thick. The upper 28 inches of the subsoil is dark brown loam and clay loam, and the lower 9 inches is dark brown gravelly loam. Bedrock is at a depth of 52 inches. Depth to bedrock is 40 to 60 inches or more.

Permeability of the Wilhoit soil is moderate. Available water capacity is about 6.5 to 10.5 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. On the Fernwood soil, the site index for Douglas-fir ranges from 100 to 130. On the basis of a site index of 115, the potential production per acre of merchantable timber is 6,360 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 57,960 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

On the Wilhoit soil, the site index for Douglas-fir ranges from 140 to 160. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

Conventional methods of harvesting timber generally are suitable, but the soils in this unit may become compacted if heavy equipment is used while the soils are wet. Coarse fragments in the Fernwood soil cause droughtiness, which reduces seedling survival. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIs.

35D—Gapcot gravelly loam, 3 to 30 percent slopes. This shallow, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from sandstone. The native vegetation is mainly Oregon white oak, poison-oak, trailing blackberry, scattered Douglas-fir, and grasses (fig. 9). Elevation is 500 to 1,800 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown gravelly loam about 10 inches thick. The subsoil is brown gravelly clay loam about 5 inches thick. Sandstone is at a depth of 15 inches. Depth to sandstone ranges from 10 to 20 inches.

Included in this unit are small areas of Springwater and Hardscrabble soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Gapcot soil is moderate. Available water capacity is about 2 to 4 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used for crops such as pasture and grass seed and as homesites and wildlife habitat.

If this unit is used for grass seed or pasture, the main limitations are depth to rock, slope, and the restricted available water capacity. Plowing may expose bedrock in some areas. Tillage should be kept to a minimum. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

If this unit is used for homesite development, the main limitations are depth to rock, slope, and low soil strength. Excavations for installing utilities and septic tank absorption fields are limited by depth to bedrock. Cuts needed to provide essentially level building sites can expose bedrock. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass VIs.

35E—Gapcot gravelly loam, 30 to 60 percent slopes. This shallow, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from sandstone. The native vegetation is mainly Oregon white oak, poison-oak, trailing blackberry, scattered Douglas-fir, and grasses. Elevation is 500 to 1,800 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown gravelly loam about 10 inches thick. The subsoil is brown gravelly clay loam about 5 inches thick. Sandstone is at a depth of 15 inches. Depth to sandstone ranges from 10 to 20 inches.

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

Permeability of this Gapcot soil is moderate. Available water capacity is about 2 to 4 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is rapid, and the hazard of water erosion is severe. This soil is droughty in summer.

This unit is used for pasture and as homesites and wildlife habitat.

The production of forage on this unit is limited by the restricted available water capacity. Slope limits access by livestock and results in overgrazing of the less sloping areas. Livestock grazing should be managed to protect the soil from excessive erosion.

Figure 9.—Oregon white oak, grasses, and scattered Douglas-fir on Gapcot gravelly loam, 3 to 30 percent slopes.

If this unit is used for homesite development, the main limitations are depth to rock, steepness of slope, and low soil strength. Excavations for installing utilities and septic tank absorption fields are limited by the depth to bedrock. Cuts needed to provide essentially level building sites can expose bedrock. Preserving the existing plant cover during construction helps to control erosion. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass VIe.

36B—Hardscrabble silt loam, 2 to 7 percent slopes. This deep, somewhat poorly drained soil is on rolling uplands. It formed in clayey alluvium. The vegetation in areas not cultivated is mainly Oregon white oak, western hazel, rose, blackberry, grasses, and scattered Douglas-fir. Elevation is 150 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The upper 6 inches of the subsoil is dark brown silty clay loam, and the lower 19 inches is brown clay. The substratum to a depth of 60 inches or more is brown clay. Depth to clay ranges from 12 to 24 inches.

Included in this unit are small areas of Jory, Saum, Cottrell, Helvetia, and Powell soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Hardscrabble soil is very slow. Available water capacity is about 7.0 to 10.5 inches. Effective rooting depth is 20 to 30 inches. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 6 to 18 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, and small grain. It is also used as homesites and

wildlife habitat. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Hardscrabble soils that have been cut or graded.

If this unit is used for hay and pasture, the main limitation is wetness. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to cultivated crops. It is limited mainly by wetness and the restricted rooting depth. Wetness generally limits the suitability of this unit for deep-rooted crops. Drainage of the soil is difficult because of the very slow permeability. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed.

If this unit is used for homesite development, the main limitations are wetness, the very slow permeability, a high potential for shrinking and swelling, and low soil strength. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. Septic tank absorption fields do not function properly during rainy periods because of wetness and the very slow permeability.

In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIIw.

36C—Hardscrabble silt loam, 7 to 20 percent slopes. This deep, somewhat poorly drained soil is on rolling uplands. It formed in clayey alluvium. The vegetation in areas not cultivated is mainly Oregon white oak, western hazel, rose, blackberry, grasses, and scattered Douglas-fir. Elevation is 150 to 600 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The upper 6 inches of the subsoil is dark brown silty clay loam, and the lower 19 inches is brown clay. The substratum to a depth of 60 inches or more is brown clay. Depth to clay ranges from 12 to 24 inches.

Included in this unit are small areas of Jory, Saum, Cottrell, Helvetia, and Powell soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Hardscrabble soil is very slow. Available water capacity is about 7.0 to 10.5 inches. Effective rooting depth is 20 to 30 inches. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 6 to 18 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, and small grain (fig. 10) and as homesites and wildlife habitat. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 24 inches of fill material or have had as much as 36 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Hardscrabble soils that have been cut or graded.

If this unit is used for hay and pasture, the main limitations are steepness of slope and wetness. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to cultivated crops. It is limited mainly by wetness, the restricted rooting depth, and slope. Wetness generally limits the suitability of this unit for deep-rooted crops. Drainage of the soil is difficult because of the very slow permeability. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

If this unit is used for homesite development, the main limitations are wetness, the very slow permeability, a

Figure 10.—Winter wheat on Hardscrabble silt loam, 7 to 20 percent slopes.

high potential for shrinking and swelling, low soil strength, and slope. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. Preserving the existing plant cover during construction helps to control erosion.

In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

Septic tank absorption fields do not function properly during rainy periods because of wetness and the very slow permeability. Slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass IVe.

37B—Helvetia silt loam, 3 to 8 percent slopes. This deep, moderately well drained soil is on high terraces. It formed in mixed old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western hazel, poison-oak and other shrubs, and grasses. Elevation is 250 to 500 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 14 inches thick. The upper 7 inches of the subsoil is dark brown silty clay loam, and the lower 19 inches is brown silty clay. The substratum to a depth of 60 inches or more is brown silty clay loam.

Included in this unit are small areas of Laurelwood, Saum, Hardscrabble, and Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Helvetia soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 36 to 72 inches in winter and early in spring.

This unit is used mainly for crops such as small grain, hay, and pasture. Berries and orchard crops are also grown. Some areas of the unit are used for timber production and as homesites and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by wetness. Tile drainage can be used to reduce wetness if a suitable outlet is available. Most climatically adapted crops can be grown if drainage is provided. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is wetness. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and poison-oak limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness, the moderately slow permeability, low soil strength, and a moderate potential for shrinking and swelling. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

37C—Helvetia silt loam, 8 to 15 percent slopes. This deep, moderately well drained soil is on high terraces. It formed in mixed old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western hazel, poison-oak and other shrubs, and grasses. Elevation is 250 to 500 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 14 inches thick. The upper 7 inches of the subsoil is dark brown silty clay loam, and the lower 19 inches is brown silty clay. The substratum to a depth of 60 inches or more is brown silty clay loam.

Included in this unit are small areas of Laurelwood, Saum, Hardscrabble, and Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Helvetia soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 36 to 72 inches in winter and early in spring.

This unit is used mainly for crops such as pasture, hay, and small grain. Orchard crops are also grown. Some areas of the unit are used for timber production and as homesites and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by wetness and slope. Tile drainage can be used to reduce wetness if a suitable outlet is available. Most climatically adapted crops can be grown if drainage is provided. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is wetness. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is

wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and poison-oak limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are wetness, the moderately slow permeability, low soil strength, and a moderate potential for shrinking and swelling. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

37D—Helvetia silt loam, 15 to 30 percent slopes. This deep, moderately well drained soil is on high terraces. It formed in mixed old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western hazel, poison-oak and other shrubs, and grasses. Elevation is 250 to 500 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 14 inches thick. The upper 7 inches of the subsoil is dark brown silty clay loam, and the lower 19 inches is brown silty clay. The substratum to a depth of 60 inches or more is brown silty clay loam.

Included in this unit are small areas of Laurelwood, Saum, and Hardscrabble soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Helvetia soil is moderately slow. Available water capacity is about 11 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. The water table is at a depth of 36 to 72 inches in winter and early in spring.

This unit is used mainly for pasture and timber production and as homesites and wildlife habitat.

If this unit is used for pasture, the main limitation is steepness of slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are wetness and steepness of slope. The steepness of slope limits the kinds of equipment that can be used in forest management. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and poison-oak limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, wetness, the moderately slow permeability, a moderate potential for shrinking and swelling, and low soil strength. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Slope is a concern in installing septic tank absorption fields.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IVe.

38E—Highcamp very gravelly loam, 30 to 60 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in colluvium derived dominantly from andesite mixed with volcanic ash. The native vegetation is mainly western hemlock, noble fir (fig. 11), Douglas-fir, rhododendron, beargrass, big huckleberry, red huckleberry, and swordfern. Elevation is 2,800 to 4,800 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 30 to 90 days.

Typically, the surface layer is very dark grayish brown very gravelly loam about 8 inches thick. The subsoil is dark brown and brown very cobbly loam about 31 inches thick. The substratum is yellowish brown extremely cobbly loam about 6 inches thick. Fractured andesite is at a depth of 45 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Kinzel, Divers, and Soosap soils and Rock outcrop. Included areas make up about 20 percent of the total acreage.

Permeability of this Highcamp soil is moderately rapid. Available water capacity is about 3.5 to 9.0 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

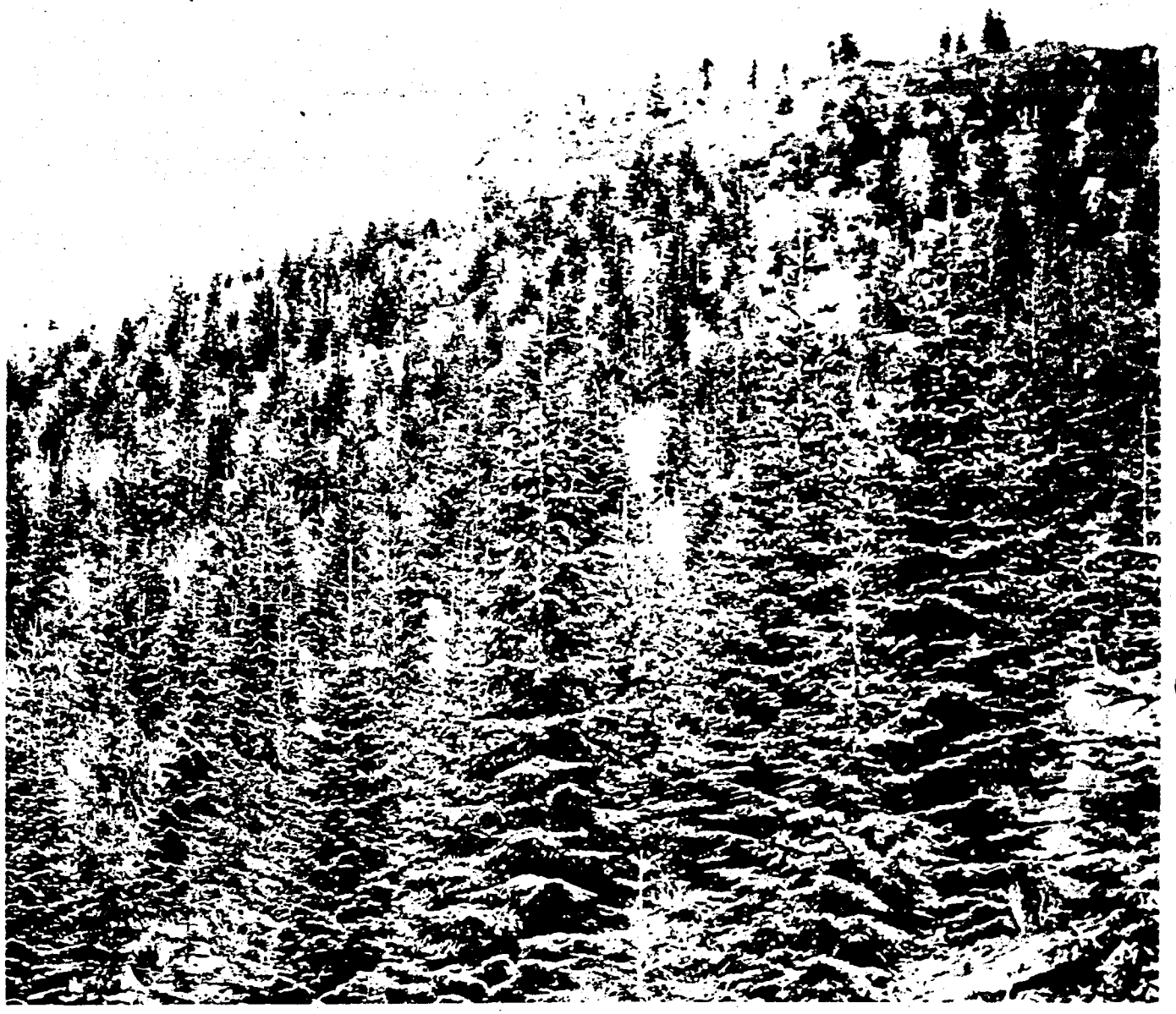


Figure 11.—Young stand of noble fir on Highcamp very gravelly loam, 30 to 60 percent slopes.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 100 to 120. On the basis of a site index of 110, the potential production per acre of merchantable timber is 5,880 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 58,100 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old. The main concerns in producing and harvesting timber are slope, the restricted rooting depth, cold soil temperatures, and the content of rock fragments.

The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used. Logging may be restricted during December through April because of a deep accumulation of snow.

Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Trees are subject to windthrow because of the restricted rooting depth. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Brushy plants such as big huckleberry and rhododendron limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIIs.

39F—Highcamp-Rock outcrop complex, 50 to 90 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly western hemlock, noble fir, Douglas-fir, rhododendron, beargrass, big huckleberry, red huckleberry, and swordfern. Elevation is 2,800 to 4,800 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 30 to 90 days.

This unit is 60 percent Highcamp very gravelly loam and 20 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Kinzel, Divers, and Soosap soils and soils that are similar to this Highcamp soil but are less than 40 inches deep to bedrock. Included areas make up about 20 percent of the total acreage.

The Highcamp soil is deep and well drained. It formed in colluvium derived dominantly from andesite mixed with volcanic ash. Typically, the surface layer is very dark grayish brown very gravelly loam about 8 inches thick. The subsoil is dark brown and brown very cobbly loam about 31 inches thick. The substratum is yellowish brown extremely cobbly loam about 6 inches thick. Fractured andesite is at a depth of 45 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Permeability of the Highcamp soil is moderately rapid. Available water capacity is about 3.5 to 9.0 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of basalt and andesite. Some areas are nearly perpendicular cliffs as much as 100 feet high. Other areas are columns as much as 150 feet in diameter and 100 feet high. Rock outcrop supports vegetation only where soil material has accumulated in pockets or fractures in the rock.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is poorly suited to the production of Douglas-fir. On the Highcamp soil, the site index for Douglas-fir ranges from 100 to 120. On the basis of a site index of 110, the potential production per acre of merchantable timber is 5,880 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 58,100 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

The main concerns in producing and harvesting timber are the steepness of slope, the restricted rooting depth, cold soil temperatures, the content of rock fragments, and the areas of Rock outcrop. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other logging methods that fully or partially suspend logs reduce the disturbance of the soil. Severe erosion or gullying can occur where the soil is disturbed. Landsliding and slumping can result where roads are constructed. Logging may be restricted during December through April because of a deep accumulation of snow. The areas of Rock outcrop make felling and yarding difficult.

Trees are subject to windthrow because of the restricted rooting depth. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Brushy plants such as big huckleberry and rhododendron limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIIs.

40D—Highcamp-Soosap complex, 5 to 30 percent slopes. This map unit is on ridgetops and in saddles on mountainous uplands. The native vegetation is mainly noble fir (fig. 12), western hemlock, Douglas-fir, vine maple, rhododendron, big huckleberry, red huckleberry, beargrass, Oregon-grape, and salal. Elevation is 2,800 to 4,800 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 30 to 90 days.

This unit is 45 percent Highcamp very gravelly loam and 40 percent Soosap loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Kinzel and Divers soils, Rock outcrop, and soils that are similar to the Highcamp soil but are less than 40 inches deep to bedrock. Included areas make up about 15 percent of the total acreage.

The Highcamp soil is deep and well drained. It formed in colluvium derived dominantly from andesite mixed with volcanic ash. Typically, the surface layer is very dark grayish brown very gravelly loam about 8 inches thick. The subsoil is dark brown and brown very cobbly loam about 31 inches thick. The substratum is yellowish brown extremely cobbly loam about 6 inches thick. Fractured andesite is at a depth of 45 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Permeability of the Highcamp soil is moderately rapid. Available water capacity is about 3.5 to 9.0 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

The Soosap soil is moderately deep and well drained. It formed in colluvium derived dominantly from tuff,

Figure 12.—A stand of noble fir on Soosap loam.

breccia, and andesite mixed with volcanic ash. Typically, the surface layer is very dark brown gravelly loam and loam about 13 inches thick. The subsoil is very dark grayish brown loam about 22 inches thick. Soft, weathered tuff is at a depth of 35 inches. Depth to tuff ranges from 20 to 40 inches.

Permeability of the Soosap soil is moderate. Available water capacity is about 3 to 7 inches. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is suited to the production of Douglas-fir. On the Highcamp soil, the site index for Douglas-fir ranges from 100 to 120. On the basis of a site index of 110, the potential production per acre of merchantable timber is

5,880 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 58,100 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

On the Soosap soil, the site index for Douglas-fir ranges from 110 to 130. On the basis of a site index of 120, the potential production per acre of merchantable timber is 6,900 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 63,900 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are the the restricted rooting depth, cold soil temperatures, and the content of rock fragments in the Highcamp soil. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Logging may be restricted during December through April because of a deep accumulation of snow. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Trees are subject to windthrow because of the restricted rooting depth. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Brushy plants such as big huckleberry and rhododendron limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

41—Huberly silt loam. This deep, poorly drained soil is in swales of valley terraces. It formed in stratified glaciolacustrine deposits. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly ash, willows, western hazel, sedges, western redcedar, and grasses. Elevation is 150 to 250 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The next 16 inches is grayish brown silt loam. Below this to a depth of 60 inches or more is a dark grayish brown, gray, and brown silt loam hardpan. Depth to the hardpan ranges from 20 to 30 inches.

Included in this unit are small areas of Dayton, Amity, Aloha, and Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Huberly soil is slow. Available water capacity is about 4 to 7 inches. Effective rooting depth is restricted by the hardpan. Runoff is slow to ponded, and the hazard of water erosion is slight. The water table is at a depth of 0 to 18 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, and spring grain. Vegetables are also grown. Some areas of the unit are used as wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by wetness, the slow permeability, and the restricted rooting depth. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables respond to nitrogen, phosphorus, and potassium. Diversions and grassed waterways may be needed.

If this unit is used for homesite development, the main limitations are wetness and the slow permeability. Drainage should be provided for buildings with basements and crawl spaces. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods.

In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIIw.

42—Humaquepts, ponded. These deep, poorly drained soils are on flood plains and old lake bottoms. They formed in lacustrine material over peat. Slope is 0 to 2 percent. The native vegetation is mainly sedges, willows, cottonwood, and blackberry. Elevation is 100 to 300 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

No single profile of Humaquepts is typical, but one commonly observed in the survey area has a surface layer of black mucky clay about 24 inches thick. The next layer is black peat about 26 inches thick. The substratum to a depth of 60 inches or more is very dark gray and dark grayish brown silt loam. Depth to peat ranges from 20 to 36 inches, and it extends to a depth of 50 to 80 inches or more.

Included in this unit are small areas of Wapato and Cove soils. Included areas make up about 15 percent of the total acreage.

Permeability of these Humaquepts is slow. Available water capacity is about 12 to 15 inches. Effective rooting depth is restricted by the layer of peat. Runoff is slow to ponded, and the hazard of water erosion is slight. The water table is at a depth of 0 to 6 inches in winter and

early in spring. These soils are subject to brief periods of flooding in winter.

This unit is used for crops such as vegetables, hay, and pasture and as homesites and wildlife habitat.

If this unit is used for cultivated crops, the main limitations are wetness, the restricted rooting depth, and the brief periods of flooding. Drainage is needed to keep the water table below the root zone. Open ditches or shallow tile drainage systems can be used where outlets are available. The risk of flooding is reduced by the use of dikes and levees. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are wetness, low soil strength, the hazard of flooding, the slow permeability, and susceptibility of the soil to compaction.

This map unit is in capability subclass IIIw.

43D—Humaquepts, 2 to 20 percent slopes. These moderately deep and deep, somewhat poorly drained and poorly drained soils are in drainageways and basins of uplands. They formed in colluvium and alluvium derived dominantly from andesite and basalt. The native vegetation is mainly red alder, western redcedar, salmonberry, devilsclub, and skunkcabbage. Elevation is 500 to 2,000 feet. The average annual precipitation is 60 to 85 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 120 to 165 days.

No single profile of Humaquepts is typical, but one commonly observed in the survey area has a surface layer of dark brown gravelly silt loam about 15 inches thick. The subsoil is mottled, brown cobbly loam about 30 inches thick. The substratum to a depth of 60 inches or more is brown, slightly brittle very gravelly loam. In some areas of similar included soils, the surface layer is loam or cobbly loam. Depth to bedrock is 40 to 60 inches or more.

Included in this unit are small areas of Kinney, Klickitat, Molalla, and McCully soils. Also included are small areas of organic soils in the more nearly level areas. Included areas make up about 20 percent of the total acreage.

Permeability of these Humaquepts is moderate to slow. Available water capacity is about 5 to 10 inches. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the slightly brittle substratum.

This unit is used as water supply and wildlife habitat.

This map unit is in capability subclass VIIw.

44B—Jimbo loam, cool, 0 to 5 percent slopes. This deep, well drained soil is on stream terraces. It formed in mixed alluvium and volcanic ash. The vegetation in areas not cultivated is mainly Douglas-fir, western hemlock, we stern redcedar, red alder, vine maple, salal, and oxalis. Elevation is 500 to 1,700 feet. The average annual precipitation is about 80 to 95 inches, the average annual air temperature is 46 to 50 degrees F, and the average frost-free period is 80 to 130 days.

Typically, the surface layer is very dark brown and very dark grayish brown loam about 18 inches thick. The subsoil is dark yellowish brown loam about 11 inches thick. The upper 18 inches of the substratum is dark yellowish brown sandy loam, and the lower part to a depth of 60 inches or more is dark yellowish brown very cobbly sand.

Included in this unit are small areas of Crutch, Multorpor, and Bull Run soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Jimbo soil is moderately rapid. Available water capacity is about 8 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for timber production, pasture, homesites, wildlife habitat, and recreation.

If this unit is used for pasture, the main limitations are the high amount of rainfall and a short growing season. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Roads for year-round use need heavy base rock. Brushy plants such as red alder and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are low soil strength and seepage. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Cutbanks are not stable and are subject to slumping.

If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass VIc.

45B—Jory silty clay loam, 2 to 8 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, poison-oak and other shrubs, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silty clay loam about 7 inches thick. The upper 6 inches of the subsoil is dark reddish brown silty clay loam, the next 30 inches is dark red and yellowish red silty clay, and the lower part to a depth of 60 inches or more is dark reddish brown and dark red silty clay.

Included in this unit are small areas of Nekia, Cottrell, Bornstedt, and Saum soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Jory soil is moderately slow. Available water capacity is about 9 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used mainly for timber production and for crops such as hay, orchard crops, berries, and grass seed. It is also used as homesites and wildlife habitat and for recreational development. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Jory soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by low fertility and by acidity. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and berries respond to nitrogen, phosphorus, and potassium.

A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling or subsoiling breaks up the tillage pan. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are a potential for shrinking and swelling, low soil strength, and the moderately slow permeability. Roads and buildings should be designed to offset the effects of shrinking and swelling and the limited ability of the soil in this unit to support a load. If the soil is used for septic tank absorption fields, the main limitation is the moderately slow permeability. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

45C—Jory silty clay loam, 8 to 15 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, poison-oak and other shrubs, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silty clay loam about 7 inches thick. The upper 6 inches of the subsoil is dark reddish brown silty clay loam, the next 30 inches is dark red and yellowish red silty clay, and the lower part to a depth of 60 inches or more is dark reddish brown and dark red silty clay.

Included in this unit are small areas of Cottrell, Bornstedt, Nekia, and Saum soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Jory soil is moderately slow. Available water capacity is about 9 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used mainly for timber production (fig. 13) and crops such as hay, orchard crops, berries, and grass seed. It is also used as homesites and wildlife habitat and for recreational development.

This unit is suited to cultivated crops. It is limited mainly by slope, moderate fertility, and acidity. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and berries respond to nitrogen, phosphorus, and potassium.

If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be

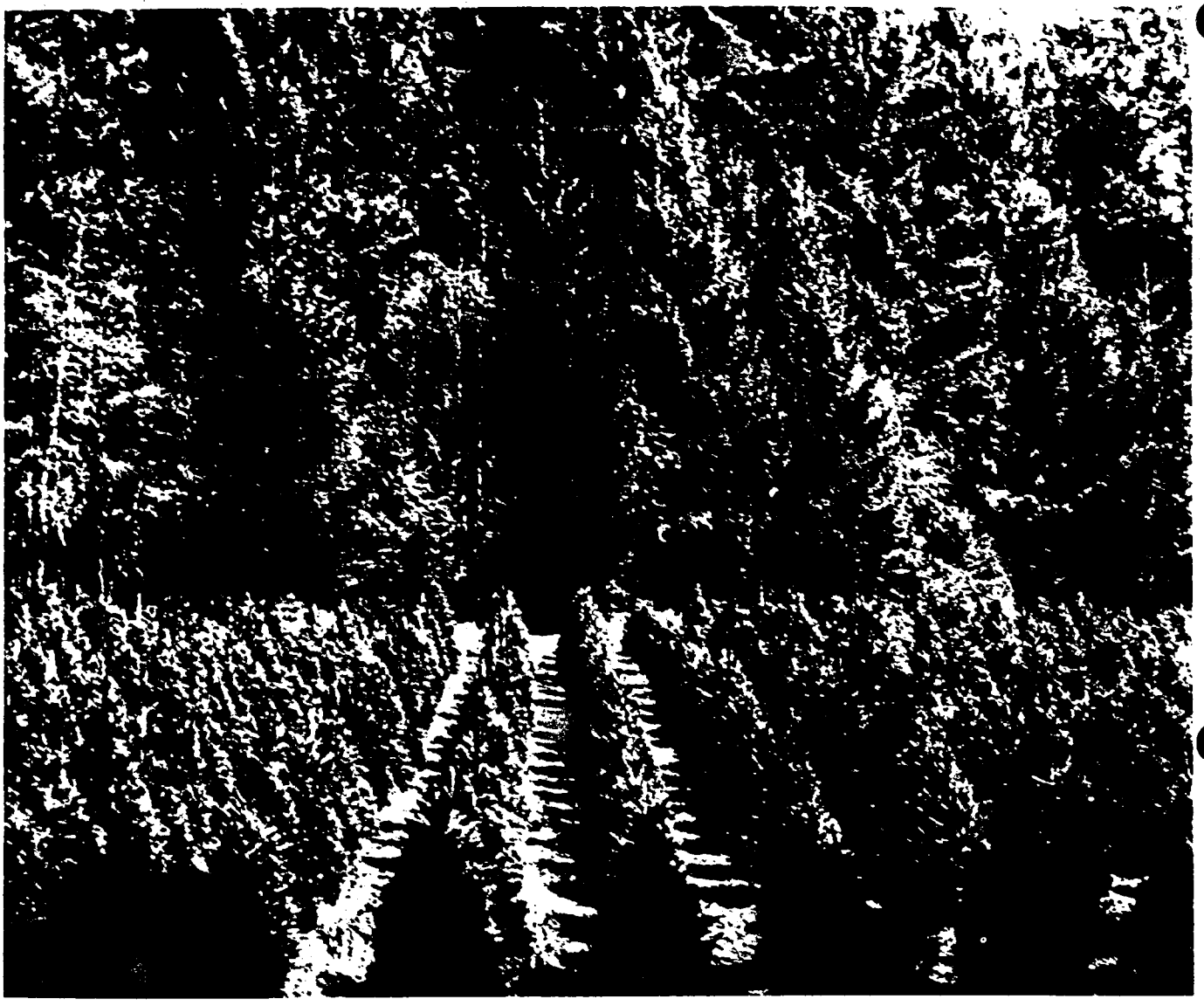


Figure 13.—Christmas trees on Jory silty clay loam, 8 to 15 percent slopes.

needed. A tillage pan forms easily if this soil is tilled when wet. Chiseling or subsoiling breaks up the tillage pan. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are low soil strength and the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

45D—Jory silty clay loam, 15 to 30 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, poison-oak and other shrubs, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silty clay loam about 7 inches thick. The upper 6 inches of the subsoil is dark reddish brown silty clay loam, the next 30 inches is dark red and yellowish red silty clay, and the lower part to a depth of 60 inches or more is dark reddish brown and dark red silty clay.

Included in this unit are small areas of Nekia, Bornstedt, and Saum soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Jory soil is moderately slow. Available water capacity is about 9 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe. This soil is droughty in summer.

This unit is used mainly for timber production and pasture. It is also used as homesites and wildlife habitat and for recreational development.

If this unit is used for hay and pasture, the main limitation is steepness of slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is steepness of slope. The steepness of slope limits the kinds of equipment that can be used in forest management. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, low soil strength, and the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. Slope is a concern in installing septic tank absorption fields.

Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IVe.

45E—Jory silty clay loam, 30 to 60 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, poison-oak and other shrubs, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silty clay loam about 7 inches thick. The upper 6 inches of the subsoil is dark reddish brown silty clay loam, the next 30 inches is dark red and yellowish red silty clay, and the lower part to a depth of 60 inches or more is dark reddish brown and dark red silty clay.

Included in this unit are small areas of Xerochrepts, Haploxerolls, and Saum soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Jory soil is moderately slow. Available water capacity is about 9 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used mainly for timber production. It is also used as homesites and wildlife habitat.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is steepness of slope. Conventional methods of harvesting timber are difficult to use because of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during December through March. Roads for year-round use need heavy base rock. Roads and landings can be protected from

erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, low soil strength, and the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. This unit generally is too steep to install septic tank absorption fields. Absorption lines should be placed in adjoining areas that are more nearly level. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass VIe.

46B—Jory stony silt loam, 3 to 8 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, poison-oak, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown stony silt loam about 8 inches thick. The subsoil to a depth of 60 inches or more is mainly reddish brown stony silty clay.

Included in this unit are small areas of Saum, Nekia, Ritner, Cottrell, and Laurelwood soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Jory soil is moderately slow. Available water capacity is about 7.0 to 9.5 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used mainly for timber production and pasture. It is also used for hay and as homesites and wildlife habitat.

If this unit is used for hay and pasture, it is limited mainly by the stoniness of the surface layer. Stones on the surface limit the use of most equipment. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 155. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the stoniness of the surface layer. Stones on the surface can interfere with felling, yarding, and other operations involving the use of equipment. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as hazel and poison-oak limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the high content of stones in the soil and the moderately slow permeability. The stones in the subsoil interfere with excavation for installing utilities (fig. 14). If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IVs.

46C—Jory stony silt loam, 8 to 15 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, poison-oak, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown stony silt loam about 8 inches thick. The subsoil to a depth of 60 inches or more is mainly reddish brown stony silty clay.

Included in this unit are small areas of Saum, Nekia, Ritner, Cottrell, and Laurelwood soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Jory soil is moderately slow. Available water capacity is about 7.0 to 9.5 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used mainly for timber production, hay, and pasture. It is also used as wildlife habitat and homesites.

If this unit is used for hay and pasture, it is limited mainly by the stoniness of the surface layer and steepness of slope. Stones on the surface limit the use of most equipment. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. All tillage should be on the contour or across the slope. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 155. On the basis of a site index of 150, the potential production per

Figure 14.—Large stones and boulders uncovered during excavation and leveling operations on Jory stony silt loam, 3 to 8 percent slopes.

acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 80 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the stoniness of the surface layer. Stones on the surface can interfere with felling, yarding, and other operations involving the use of equipment. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as hazel and poison-oak limit natural regeneration of Douglas-fir in this soil.

This unit is poorly suited to homesite development. The main limitations are the high content of stones in the soil and the moderately slow permeability. The stones in the subsoil interfere with excavation for installing utilities. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. Slope is a concern in installing septic tank absorption fields.

Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass VIs.

46D—Jory stony silt loam, 15 to 30 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, poison-oak, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown stony silt loam about 8 inches thick. The subsoil to a depth of 60 inches or more is mainly reddish brown stony silty clay.

Included in this unit are small areas of Saum, Nekia, Ritner, and Witzel soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Jory soil is moderately slow. Available water capacity is about 7.0 to 9.5 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used mainly for timber production and pasture. It is also used as wildlife habitat and homesites.

If this unit is used for pasture, it is limited mainly by the stoniness of the surface layer and steepness of slope. Stones on the surface limit the use of most equipment. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. All tillage should be on the contour or across the slope. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 150. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are the stoniness of the surface layer and steepness of slope. Stones on the surface can interfere with felling, yarding, and other operations involving the use of equipment. The steepness of slope limits the kinds of equipment that can be used in forest management. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and poison-oak limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the high content of stones in the soil, the moderately slow permeability, and steepness of slope. The stones in the subsoil interfere with excavation for installing utilities. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. Slope is a concern in installing septic tank absorption fields.

Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass VIs.

47C—Kinney cobbly loam, 3 to 20 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from tuff and breccia. The native vegetation is mainly Douglas-fir, western hemlock, vine maple, Oregon-grape, salal, and swordfern. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 120 to 165 days.

Typically, the surface layer is very dark grayish brown and dark brown cobbly loam about 19 inches thick. The upper 9 inches of the subsoil is dark brown cobbly clay loam, and the lower 13 inches is dark brown cobbly loam. The substratum is brown cobbly loam about 19 inches thick. Weathered tuff and breccia are at a depth of 40 to 60 inches or more.

Included in this unit are small areas of Klickitat, Aschoff, and McCully soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Kinney soil is moderate. Available water capacity is about 6 to 13 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

Most areas of this unit are used for timber production and as wildlife habitat. A few areas are used for pasture and as homesites.

If this unit is used for pasture, the main limitations are a short growing season, cobbles and gravel on the surface, and steepness of slope. The use of equipment is limited by cobbles on the surface and by slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 160. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the content of rock fragments in the soil and slope. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. Topsoil can be stockpiled and used to reclaim areas disturbed during

construction. Slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass VIe.

47E—Kinney cobbly loam, 20 to 50 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from tuff and breccia. The native vegetation is mainly Douglas-fir, western hemlock, vine maple, Oregon-grape, salal, and swordfern. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 120 to 165 days.

Typically, the surface layer is very dark grayish brown and dark brown cobbly loam about 19 inches thick. The upper 9 inches of the subsoil is dark brown cobbly clay loam, and the lower 13 inches is dark brown cobbly loam. The substratum is brown cobbly loam about 19 inches thick. Weathered tuff and breccia are at a depth of 40 to 60 inches or more.

Included in this unit are small areas of Klickitat, Aschoff, and McCully soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Kinney soil is moderate. Available water capacity is about 6 to 13 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 160. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is steepness of slope. The steepness of slope limits the kinds of equipment that can be used in forest management. The high-lead logging method is more efficient than most other methods and is less damaging to the soil surface. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

48B—Kinton silt loam, 3 to 8 percent slopes. This deep, moderately well drained soil is on rolling uplands. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, western hazel, poison-oak and other shrubs, and grasses. Elevation is 250 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 15 inches thick. The subsoil is brown silt loam 20 inches thick. Below this to a depth of 60 inches or more is a brown silt loam hardpan. Depth to the hardpan ranges from 30 to 40 inches.

Included in this unit are small areas of Cascade, Powell, Delena, and Cornelius soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Kinton soil is moderate to a depth of 35 inches and slow below this depth. Available water capacity is about 7 to 9 inches. Effective rooting depth is restricted by the hardpan. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 30 to 48 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, small grain, filberts, and berries. It is also used for timber production and as homesites and wildlife habitat.

If this unit is used for cultivated crops, the main limitations are wetness and the restricted rooting depth. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile systems are difficult to install because of the depth to the hardpan. They should be installed across the slope.

In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and berries respond to nitrogen, phosphorus, and potassium.

If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are wetness and the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water

bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the slow permeability, wetness, and low soil strength. Because of the depth to the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

48C—Kinton silt loam, 8 to 15 percent slopes. This deep, moderately well drained soil is on rolling uplands. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, western hazel, poison-oak and other shrubs, and grasses. Elevation is 250 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 15 inches thick. The subsoil is brown silt loam 20 inches thick. Below this to a depth of 60 inches or more is a brown silt loam hardpan. Depth to the hardpan ranges from 30 to 40 inches.

Included in this unit are small areas of Cascade, Powell, Delena, and Cornelius soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Kinton soil is moderate to a depth of 35 inches and slow below this depth. Available water capacity is about 7 to 9 inches. Effective rooting depth is restricted by the hardpan. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 30 to 48 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, and small grain. Filberts are also grown. Some areas of the unit are used for timber production and as homesites and wildlife habitat.

If this unit is used for cultivated crops, the main limitations are slope, wetness, and the restricted rooting depth. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile systems are difficult to install because of the depth to the hardpan. They should be installed across the slope.

In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are wetness and the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the slow permeability, wetness, low soil strength, and slope. Because of the depth to the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

48D—Kinton silt loam, 15 to 30 percent slopes. This deep, moderately well drained soil is on rolling uplands. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, bigleaf maple, western redcedar, western hazel, poison-oak and other shrubs, and grasses. Elevation is 250 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 15 inches thick. The subsoil is brown silt loam 20 inches thick. Below this to a depth of 60 inches or more is a brown silt loam hardpan. Depth to the hardpan ranges from 30 to 40 inches.

Included in this unit are small areas of Cornelius, Cascade, Powell, and Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Kinton soil is moderate to a depth of 35 inches and slow below this depth. Available water capacity is about 7 to 9 inches. Effective rooting depth is restricted by the hardpan. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 30 to 48 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for timber production and pasture. It is also used as homesites and wildlife habitat.

If this unit is used for pasture, the main limitation is steepness of slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 165, the potential production per acre of merchantable timber is 10,560 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are slope, wetness, and the restricted rooting depth. The steepness of slope limits the kinds of equipment that can be used in forest management. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, wetness, the slow permeability, and low soil strength. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

Because of the depth to the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall. Slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass IVe.

49D—Kinzel-Divers complex, 5 to 30 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly Douglas-fir, noble fir, western hemlock, vine maple, big huckleberry, rhododendron, beargrass, and Oregon-grape. Elevation is 2,800 to 4,800 feet. The average annual precipitation is 75 to 110 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 20 to 45 days.

This unit is 50 percent Kinzel very gravelly silt loam and 35 percent Divers gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Highcamp and Soosap soils and Rock outcrop. Included areas make up about 15 percent of the total acreage.

The Kinzel soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is very dark grayish brown and dark brown very gravelly silt loam about 17 inches thick. The subsoil is brown extremely cobbly loam about 26 inches thick. The substratum to a depth of 60 inches or more is brown extremely cobbly loam. In some areas of similar included soils, the surface layer is gravelly silt loam.

Permeability of the Kinzel soil is moderately rapid. Available water capacity is about 7 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

The Divers soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is dark brown gravelly loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown gravelly loam, and the lower 27 inches is dark brown very cobbly loam. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam.

Permeability of the Divers soil is moderately rapid. Available water capacity is about 4 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is suited to the production of Douglas-fir, western hemlock, and noble fir. On the Kinzel soil, the site index for Douglas-fir ranges from 100 to 120. On the basis of a site index of 111, the potential production per acre of merchantable timber is 6,000 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 59,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

On the Divers soil, the site index for Douglas-fir ranges from 95 to 110. On the basis of a site index of 105, the potential production per acre of merchantable timber is 5,460 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 52,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

The main concerns in producing and harvesting timber are the cold soil temperatures, slope, and the content of rock fragments in the soils. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the

soil is wet. Landsliding and slumping can result where roads are constructed. Logging may be restricted during December through April because of a deep accumulation of snow.

Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Droughtiness caused by coarse fragments in the soils reduces seedling survival. Brushy plants such as rhododendron and big huckleberry limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

49E—Kinzel-Divers complex, 30 to 60 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly Douglas-fir, noble fir, western hemlock, vine maple, big huckleberry, rhododendron, beargrass, and Oregon-grape. Elevation is 2,800 to 4,800 feet. The average annual precipitation is 75 to 110 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 20 to 45 days.

This unit is 45 percent Kinzel very gravelly silt loam and 35 percent Divers gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Highcamp and Soosap soils and Rock outcrop. Included areas make up about 20 percent of the total acreage.

The Kinzel soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is very dark grayish brown and dark brown very gravelly silt loam about 17 inches thick. The subsoil is brown extremely cobbly loam about 27 inches thick. The substratum to a depth of 60 inches or more is brown extremely cobbly loam. In some areas of similar included soils, the surface layer is gravelly silt loam.

Permeability of the Kinzel soil is moderately rapid. Available water capacity is about 7 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

The Divers soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is dark brown gravelly loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown gravelly loam, and the lower 27 inches is dark brown very cobbly loam. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam.

Permeability of the Divers soil is moderately rapid. Available water capacity is about 4 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is suited to the production of Douglas-fir, western hemlock, and noble fir. On the Kinzel soil, the site index for Douglas-fir ranges from 100 to 120. On the basis of a site index of 111, the potential production per acre of merchantable timber is 6,000 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 59,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

On the Divers soil, the site index for Douglas-fir ranges from 95 to 110. On the basis of a site index of 105, the potential production per acre of merchantable timber is 5,460 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 52,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

The main concerns in producing and harvesting timber are the cold soil temperatures, slope, and the content of rock fragments in the soils. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used for harvesting timber. Logging may be restricted during December through April because of a deep accumulation of snow. Landsliding and slumping can result where roads are constructed.

Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Droughtiness caused by coarse fragments in the soils reduces seedling survival. Brushy plants such as rhododendron and big huckleberry limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIIe.

49F—Kinzel-Divers complex, 60 to 90 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly Douglas-fir, noble fir, western hemlock, vine maple, big huckleberry, rhododendron, beargrass, and Oregon-grape. Elevation is 2,800 to 4,800 feet. The average annual precipitation is 75 to 110 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 20 to 45 days.

This unit is 40 percent Kinzel very gravelly silt loam and 35 percent Divers gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Highcamp and Soosap soils and Rock outcrop. Included areas make up about 25 percent of the total acreage.

The Kinzel soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is very dark grayish brown and dark brown very gravelly silt loam about 17 inches thick. The subsoil is brown very gravelly loam about 27 inches thick. The substratum to a depth of 60 inches or more is brown extremely cobbly loam.

Permeability of the Kinzel soil is moderately rapid. Available water capacity is about 7 to 11 inches.

Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

The Divers soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is dark brown gravelly loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown gravelly loam, and the lower 27 inches is dark brown very cobbly loam. The substratum to a depth of 60 inches or more is dark yellowish brown extremely cobbly loam.

Permeability of the Divers soil is moderately rapid. Available water capacity is about 4 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is suited to the production of Douglas-fir, western hemlock, and noble fir. On the Kinzel soil, the site index for Douglas-fir ranges from 100 to 120. On the basis of a site index of 111, the potential production per acre of merchantable timber is 6,000 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 59,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

On the Divers soil, the site index for Douglas-fir ranges from 95 to 110. On the basis of a site index of 105, the potential production per acre of merchantable timber is 5,460 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 52,400 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

The main concerns in producing and harvesting timber are slope, cold soil temperatures, and the content of rock fragments in the soils. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other logging methods that fully or partially suspend logs reduce the disturbance of the soil. Severe erosion or gullying can occur where the soil is disturbed. Landsliding and slumping can result where roads are constructed. Logging may be restricted during December through April because of a deep accumulation of snow.

Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Droughtiness caused by coarse fragments in the soils reduces seedling survival. Brushy plants such as rhododendron and big huckleberry limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIIe.

51E—Klickitat stony loam, 30 to 60 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in colluvium derived dominantly from andesite and basalt. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, dogwood, salal, and swordfern. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 120 to 165 days.

Typically, the surface layer is dark brown and dark reddish brown stony loam about 15 inches thick. The upper 13 inches of the subsoil is dark reddish brown very gravelly clay loam, and the lower 7 inches is reddish brown very cobbly clay loam. The substratum is reddish brown extremely cobbly loam about 13 inches thick. Fractured basalt is at a depth of 48 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Kinney soils and soils that are similar to this Klickitat soil but are less than 40 inches deep to bedrock. Included areas make up about 20 percent of the total acreage.

Permeability of this Klickitat soil is moderate. Available water capacity is about 2 to 5 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is suited to the production of Douglas-fir and western hemlock. The site index for Douglas-fir ranges from 135 to 155. On the basis of a site index of 144, the potential production per acre of merchantable timber is 9,000 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 81,120 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are the content of rock fragments, steepness of slope, and the instability of the soils. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used for harvesting timber. Use of these methods is limited during December through March. Landsliding and slumping can result where roads are constructed. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

Stones on the surface can interfere with felling, yarding, and other operations involving the use of equipment. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Brushy plants such as vine maple and red alder limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIs.

52D—Klickitat-Kinney complex, 5 to 30 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, dogwood, salal, and swordfern. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 120 to 165 days.

This unit is 55 percent Klickitat stony loam and 30 percent Kinney cobbly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Molalla and McCully soils. Included areas make up about 15 percent of the total acreage.

The Klickitat soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt. Typically, the surface layer is dark brown and dark reddish brown stony loam about 15 inches thick. The upper 13 inches of the subsoil is dark reddish brown very gravelly clay loam, and the lower 7 inches is reddish brown very cobbly clay loam. The substratum is reddish brown extremely cobbly loam about 13 inches thick. Fractured andesite is at a depth of 48 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Permeability of the Klickitat soil is moderate. Available water capacity is about 2 to 5 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

The Kinney soil is deep and well drained. It formed in colluvium derived dominantly from andesite, tuff, and breccia. Typically, the surface layer is very dark grayish brown and dark brown cobbly loam about 19 inches thick. The upper 9 inches of the subsoil is dark brown cobbly clay loam, and the lower 13 inches is dark brown cobbly loam. The substratum is brown cobbly clay loam about 19 inches thick. Weathered tuff and breccia are at a depth of 40 to 60 or more inches.

Permeability of the Kinney soil is moderate. Available water capacity is about 6 to 13 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production and recreation and as wildlife habitat.

This unit is suited to the production of Douglas-fir. On the Klickitat soil, the site index for Douglas-fir ranges from 135 to 155. On the basis of a site index of 144, the potential production per acre of merchantable timber is 9,000 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 81,120 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

On the Kinney soil, the site index for Douglas-fir ranges from 140 to 160. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are the instability of the soils and the content of rock fragments in the Klickitat soil. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Landsliding and slumping can result where roads are constructed. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

Stones on the surface can interfere with felling, yarding, and other operations involving the use of equipment. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Brushy plants such as vine maple and red alder limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

53A—Latourell loam, 0 to 3 percent slopes. This deep, well drained soil is on terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, and grasses. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 15 inches thick. The subsoil is dark yellowish brown loam about 33 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown gravelly sandy loam.

Included in this unit are small areas of Quatama, Aloha, Woodburn, and Willamette soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Latourell soil is moderate. Available water capacity is about 8 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

Most areas of this unit are used for cultivated crops, mainly winter wheat, sweet corn, beans, alfalfa, and nursery stock. Among the other crops grown are berries, potatoes, hay, and filberts. Some areas are used as homesites and wildlife habitat and for recreational development. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 80 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Latourell soils that have been cut or graded.

This unit is suited to cultivated crops. It has few limitations. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur,

and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to homesite development. The main limitation is low soil strength. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability class I.

53B—Latourell loam, 3 to 8 percent slopes. This deep, well drained soil is on terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, and grasses. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 15 inches thick. The subsoil is dark yellowish brown loam about 33 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown gravelly sandy loam.

Included in this unit are small areas of Quatama, Aloha, Woodburn, and Willamette soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Latourell soil is moderate. Available water capacity is about 8 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

Most areas of this unit are used for cultivated crops, mainly winter wheat, sweet corn, beans, alfalfa, and nursery stock. Among the other crops grown are berries, potatoes, hay, and filberts. Some areas are used as homesites and wildlife habitat and for recreational development. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 80 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Latourell soils that have been cut or graded.

This unit is suited to cultivated crops. It has few limitations. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop.

This unit is suited to homesite development. The main limitation is low soil strength. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

53C—Latourell loam, 8 to 15 percent slopes. This deep, well drained soil is on terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, and grasses. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 15 inches thick. The subsoil is dark yellowish brown loam about 33 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown gravelly sandy loam.

Included in this unit are small areas of Quatama, Aloha, Woodburn, and Willamette soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Latourell soil is moderate. Available water capacity is about 8 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

Most areas of this unit are used for cultivated crops, mainly winter wheat, alfalfa, pasture, and filberts. Among the other crops grown are berries and nursery stock. Some areas are used as homesites and wildlife habitat and for recreational development. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 80 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 36 inches of fill material or have had as much as 48 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of Latourell soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by slope. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth.

Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

If this unit is used for homesite development, the main limitations are low soil strength and slope. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

53D—Latourell loam, 15 to 30 percent slopes. This deep, well drained soil is on terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, and grasses. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 15 inches thick. The subsoil is dark yellowish brown loam about 33 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown gravelly sandy loam.

Included in this unit are small areas of Quatama, Woodburn, and Willamette soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Latourell soil is moderate. Available water capacity is about 8 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, and small grain. It is also used as wildlife habitat and homesites.

This unit is suited to cultivated crops. It is limited mainly by slope. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

If this unit is used for homesite development, the main limitations are slope and low soil strength. Slope is a concern in installing septic tank absorption fields. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IVe.

54B—Laurelwood silt loam, 3 to 8 percent slopes. This deep, well drained soil is on rolling uplands. It formed in silty material deposited over older clayey material. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, and Oregon-grape. Elevation is 200 to 1,500 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is 51 to 53 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 10 inches thick. The subsoil is dark brown silty clay loam about 36 inches thick. The substratum to a depth of 60 inches or more is dark reddish brown silty clay.

Included in this unit are small areas of Jory, Saum, and Helvetia soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Laurelwood soil is moderate. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used mainly for crops such as small grain, orchard crops, hay, and pasture. Berries are also grown. Some areas of the unit are used for timber production and as homesites and wildlife habitat.

This unit is well suited to cultivated crops. It has few limitations. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 157, the potential production per acre of merchantable timber is 10,020 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 92,720 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the moderate permeability, low soil strength, and a potential for shrinking and swelling. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. If the unit is used for septic tank absorption fields, the main limitation is the moderate permeability. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

54C—Laurelwood silt loam, 8 to 15 percent slopes. This deep, well drained soil is on rolling uplands. It formed in silty material deposited over older clayey material. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, and Oregon-grape. Elevation is 200 to 1,500 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is 51 to 53 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 10 inches thick. The subsoil is dark brown silty clay loam about 36 inches thick. The substratum to a depth of 60 inches or more is dark reddish brown silty clay.

Included in this unit are small areas of Jory, Saum, Helvetia, and Cornelius soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Laurelwood soil is moderate. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, small grain, and orchard crops. It is also used for timber production and as homesites and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by slope. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 157, the potential production per acre of merchantable timber is 10,020 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 92,720 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, the moderate permeability, low soil strength, and a potential for shrinking and swelling. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. If the unit is used for septic tank absorption fields, the main limitation is the moderate permeability. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

54D—Laurelwood silt loam, 15 to 30 percent slopes. This deep, well drained soil is on rolling uplands. It formed in silty material deposited over older clayey material. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, and Oregon-grape. Elevation is 200 to 1,500 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is 51 to 53 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 10 inches thick. The subsoil is dark brown silty clay loam about 36 inches thick. The substratum to a depth of 60 inches or more is dark reddish brown silty clay.

Included in this unit are small areas of Saum and Jory soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Laurelwood soil is moderate. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. This soil is droughty in summer.

This unit is used mainly for timber production and pasture. It is also used as homesites and wildlife habitat.

If this unit is used for pasture, the main limitation is steepness of slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 157, the potential production per acre of merchantable timber is 10,020 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 92,720 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is slope. The steepness of slope limits the kinds of equipment that can be used in forest management. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, the moderate permeability, low soil strength, and the potential for shrinking and swelling. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Preserving the existing plant cover during construction helps to control erosion.

If the unit is used for septic tank absorption fields, the main limitation is the moderate permeability. Slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass IVe.

54E—Laurelwood silt loam, 30 to 60 percent slopes. This deep, well drained soil is on rolling uplands. It formed in silty material deposited over older clayey material. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, and Oregon-grape. Elevation is 200 to 1,500 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is 51 to 53 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 10 inches thick. The subsoil is dark brown silty clay loam about 36 inches thick. The substratum to a depth of 60 inches or more is dark reddish brown silty clay.

Included in this unit are small areas of Xerochrepts, Jory soils, Haploxerolls, and Saum soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Laurelwood soil is moderate. Available water capacity is about 7.5 to 12.0 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe. This soil is droughty in summer.

This unit is used mainly for timber production. It is also used as homesites and wildlife habitat.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 157, the potential production per acre of merchantable timber is 10,020 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 92,720 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is steepness of slope. Conventional methods of harvesting timber are difficult to use because of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during December through March. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are steepness of slope, the moderate permeability, low soil strength, and a potential for shrinking and swelling. This unit generally is too steep to install septic tank absorption fields. Absorption lines should be placed in adjoining areas that are more nearly level. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Preserving the existing plant cover during construction helps to control erosion.

This map unit is in capability subclass VIe.

55—Malabon silty clay loam. This deep, well drained soil is on stream terraces. It formed in mixed silty and clayey alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, trailing blackberry, poison-oak and other shrubs, and grasses. Elevation is 150 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown and very dark grayish brown silty clay loam about 15 inches thick. The upper 9 inches of the subsoil is dark brown silty clay loam, and the lower 24 inches is dark brown silty clay and brown silty clay loam. The substratum to a depth of 60 inches or more is brown clay loam.

Included areas in this unit are small areas of Coburg, Conser, Salem, and Clackamas soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Malabon soil is moderately slow. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

Most areas of this unit are used for cultivated crops, mainly winter wheat, sweet corn, and bush beans. Among the other crops grown are other vegetables, alfalfa, clover, strawberries, and pasture. Some areas are used as homesites and wildlife habitat and for recreational development and timber production.

This unit is well suited to cultivated crops. It has few limitations. Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

This unit is suited to homesite development. The main limitations are the moderately slow permeability, low soil strength, and a potential for shrinking and swelling. If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 170. On the basis of a site index of 166, the potential production per acre of merchantable timber is 10,620 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 99,760 board feet (International rule, one-eighth-inch kerf) from an even-aged fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are the susceptibility of the surface layer to compaction and brush competition. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as trailing blackberry, western hazel, and poison-oak limit natural regeneration of Douglas-fir.

This map unit is in capability class I.

56—McBee silty clay loam. This deep, moderately well drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon ash, black cottonwood, willow, and trailing blackberry. Elevation is 50 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown silty clay loam about 15 inches thick. The upper 20 inches of the subsoil is very dark brown, very dark grayish brown, and dark brown silty clay loam, and the lower 13 inches is mottled, dark grayish brown silty clay loam. The substratum to a depth of 60 inches or more is dark gray clay loam.

Included in this unit are small areas of Chehalis, Cloquato, Wapato, and Newberg soils. Included areas make up about 15 percent of the total acreage.

Permeability of this McBee soil is moderate. Available water capacity is about 11 to 12 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is subject to occasional, brief periods of flooding in winter. This soil is droughty in summer.

Most areas of this unit are used for cultivated crops, mainly sweet corn, beans, and small grain. Among the other crops grown are blackberries, hay, and pasture. Some areas are used as wildlife habitat and homesites and for timber production and recreation. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting and grading. The fill material is most commonly from adjacent areas of McBee soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by wetness and the occasional periods of flooding. The risk of flooding is reduced by the use of levees, dikes, and diversions. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to

phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitations are the occasional periods of flooding and wetness. Septic tank absorption fields do not function properly during periods of flooding or during rainy periods. Deep drainage reduces wetness.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 155. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are the periods of flooding, wetness, susceptibility of the surface layer to compaction, and brush competition. Seedling mortality is a concern because of the periods of flooding. Trees are subject to windthrow in winter and spring because of wetness. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as willow, trailing blackberry, and Oregon ash limit natural regeneration of Douglas-fir.

This map unit is in capability subclass IIw.

57—McBee Variant loam. This deep, somewhat poorly drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Oregon ash, red alder, bigleaf maple, Oregon white oak, vine maple, and trailing blackberry. Elevation is 50 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown loam about 14 inches thick. The upper 14 inches of the subsoil is dark brown loam, and the lower 32 inches is dark grayish brown clay loam.

Included in this unit are small areas of Chehalis, Wapato, and Cloquato soils. Included areas make up about 10 percent of the total acreage.

Permeability of this McBee Variant soil is moderate. Available water capacity is about 8 to 11 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 6 to 18 inches in winter and early in spring. This soil is subject to brief periods of flooding in winter. It is subject to scouring and deposition during the periods of flooding. This soil is droughty in summer.

This unit is used mainly for crops such as hay, pasture, and vegetables. Berries and small grain are also grown.

This unit is suited to cultivated crops. It is limited mainly by wetness and the brief periods of flooding. Tile drainage can be used to reduce wetness if a suitable outlet is available. Flooding can be controlled by the use of dikes, levees, and diversions. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth (fig. 15). Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This map unit is in capability subclass IIIw.

58C—McCully gravelly loam, 2 to 15 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from andesite and basalt. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, bigleaf maple, vine maple, salal, Oregon-grape, and swordfern. Elevation is 800 to 2,000 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 48 to 51 degrees F, and the average frost-free period is 145 to 165 days.

Typically, the surface layer is dark brown and dark reddish brown gravelly loam about 17 inches thick. The subsoil is dark reddish brown and yellowish red silty clay about 51 inches thick. Depth to soft bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Klickitat, Kinney, and Molalla soils. Included areas make up about 15 percent of the total acreage.

Permeability of this McCully soil is moderately slow. Available water capacity is about 6 to 10 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

Most areas of this unit are used for timber production, wildlife habitat, and recreation. A few areas are used for hay, pasture, and homesite development.

If this unit is used for hay and pasture, the main limitations are a short growing season and slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 165. On the basis of a site index of 160, the potential production per acre of merchantable timber is 10,200 cubic feet from an

Figure 15.—Crop residue use on McBee Variant loam.

even-aged, fully stocked stand of trees 60 years old or 95,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as salal and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the moderately slow permeability, a potential for shrinking and swelling, and low soil strength. If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. Preserving the existing plant cover during construction helps to control erosion.

This map unit is in capability subclass IIIe.

58D—McCully gravelly loam, 15 to 30 percent slopes. This deep, well drained soil is on rolling uplands.

It formed in colluvium derived dominantly from andesite and basalt. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, bigleaf maple, vine maple, salal, Oregon-grape, and swordfern. Elevation is 800 to 2,000 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 48 to 51 degrees F, and the average frost-free period is 145 to 165 days.

Typically, the surface layer is dark brown and dark reddish brown gravelly loam about 17 inches thick. The subsoil is dark reddish brown and yellowish red silty clay about 51 inches thick. Depth to soft bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Klickitat, Kinney, and Molalla soils. Included areas make up about 20 percent of the total acreage.

Permeability of this McCully soil is moderately slow. Available water capacity is about 6 to 10 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

Most areas of this unit are used for timber production, wildlife habitat, and recreation. A few areas are used for pasture and homesite development.

If this unit is used for hay and pasture, the main limitations are slope and a short growing season. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 165. On the basis of a site index of 160, the potential production per acre of merchantable timber is 10,200 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 95,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as salal and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, the moderately slow permeability, low soil strength, and a potential for shrinking and swelling. If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. Preserving the existing plant cover during construction helps to control erosion.

This map unit is in capability subclass IVe.

58E—McCully gravelly loam, 30 to 50 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from andesite and basalt. The native vegetation is mainly Douglas-fir, western hemlock, western redcedar, red alder, bigleaf maple, vine maple, salal, Oregon-grape, and swordfern. Elevation is 800 to 2,000 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 48 to 51 degrees F, and the average frost-free period is 145 to 165 days.

Typically, the surface layer is dark brown and dark reddish brown gravelly loam about 17 inches thick. The subsoil is dark reddish brown and yellowish red silty clay about 51 inches thick. Depth to soft bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Klickitat and Kinney soils. Included areas make up about 20 percent of the total acreage.

Permeability of this McCully soil is moderately slow. Available water capacity is about 6 to 10 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 165. On the basis of a site index of 160, the potential production per acre of merchantable timber is 10,200 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 95,200 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the steepness of slope. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used for harvesting timber. Use of these methods is limited during December through March. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as salal and vine maple limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

59D—Memaloose loam, 5 to 30 percent slopes. This moderately deep, well drained soil is on mountainous uplands. It formed in colluvium derived dominantly from tuff and breccia. The native vegetation is mainly Douglas-fir, western hemlock, vine maple, red huckleberry, salal, Oregon-grape, trailing blackberry, swordfern, and brackenfern. Elevation is 2,000 to 3,000

feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 60 to 110 days.

Typically, the surface layer is dark reddish brown loam about 12 inches thick. The subsoil is dark reddish brown and dark red clay loam about 24 inches thick. Tuffaceous rock is at a depth of 36 inches. Bedrock ranges from 20 to 40 inches.

Included in this unit are small areas of Wilhoit, Fernwood, and Zygore soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Memaloose soil is moderate. Available water capacity is about 4 to 8 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 100 to 120. On the basis of a site index of 110, the potential production per acre of merchantable timber is 5,880 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 58,100 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

The main concerns in producing and harvesting timber are the restricted rooting depth and low soil strength. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Trees are subject to windthrow because of the restricted rooting depth. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and salal limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

60B—Molalla cobbly loam, 2 to 8 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from tuff, breccia, and andesite. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, salal, brackenfern, and swordfern. Elevation is 800 to 1,800 feet. The average annual precipitation is 60 to 75 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark reddish brown cobbly loam about 13 inches thick. The subsoil is dark reddish brown clay loam about 31 inches thick. Tuffaceous rock is at a depth of 44 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Alspaugh, Klickitat, Cottrell, and McCully soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Molalla soil is moderate. Available water capacity is about 5 to 10 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for timber production, pasture, homesite development, and wildlife habitat.

If this unit is used for pasture, the main limitation is the cobbly surface layer. The use of equipment is limited by cobbles on the surface. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 160. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as red alder and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the cobbly surface layer and a potential for shrinking and swelling. Roads and buildings should be designed to offset the effects of shrinking and swelling. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

60C—Molalla cobbly loam, 8 to 15 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from tuff, breccia, and andesite. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, salal, brackenfern, and swordfern. Elevation is 800 to 1,800 feet. The average annual precipitation is 60 to 75 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark reddish brown cobbly loam about 13 inches thick. The subsoil is dark reddish brown clay loam about 31 inches thick. Tuffaceous rock is at a depth of 44 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Alspaugh, Klickitat, Cottrell, and McCully soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Molalla soil is moderate. Available water capacity is about 5 to 10 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production, pasture, homesite development, and wildlife habitat.

If this unit is used for pasture, the main limitations are the cobbly surface layer and slope. The use of equipment is limited by cobbles on the surface. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes. Seedbed preparation should be on the contour or across the slope where practical.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 160. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as red alder and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, the cobbly surface layer, and a potential for shrinking and swelling. Slope is a concern in installing septic tank absorption fields. Roads and buildings should be designed to offset the effects of shrinking and swelling. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

60D—Molalla cobbly loam, 15 to 30 percent slopes. This deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from tuff, breccia, and andesite. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, salal, brackenfern, and swordfern. Elevation is 800 to 1,800 feet. The average annual precipitation is 60 to 75 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 140 to 200 days.

Typically, the surface layer is dark reddish brown cobbly loam about 13 inches thick. The subsoil is dark reddish brown clay loam about 31 inches thick. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Alspaugh, Klickitat, and McCully soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Molalla soil is moderate. Available water capacity is about 5 to 10 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production, pasture, homesite development, and wildlife habitat.

If this unit is used for pasture, the main limitations are slope and the cobbly surface layer. Seedbed preparation should be on the contour or across the slope where practical. The use of equipment is limited by cobbles on the surface and by slope. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 160. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as red alder and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, the cobbly surface layer, and a potential for shrinking and swelling. Slope is a concern in installing septic tank absorption fields. Roads and buildings should be designed to offset the effects of shrinking and swelling. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IVe.

61A—Multnomah silt loam, 0 to 3 percent slopes. This deep, well drained soil is on broad terraces. It formed in gravelly mixed alluvium. The native vegetation is mainly Douglas-fir, Oregon white oak, bigleaf maple, western hazel, and grasses. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 50 inches, the

average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The upper 4 inches of the subsoil is dark brown silt loam, and the lower 14 inches is dark brown gravelly loam. The upper 12 inches of the substratum is dark brown gravelly loam, and the lower part to a depth of 60 inches or more is dark grayish brown very gravelly loamy sand.

Included in this unit are small areas of Latourell and Quatama soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Multnomah soil is moderate to a depth of 38 inches and rapid below this depth. Available water capacity is about 6 to 8 inches. Effective rooting depth is 36 to 48 inches. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used for homesite development, wildlife habitat, and recreation. The unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Multnomah soils that have been cut or graded.

This unit is suited to homesite development. It has few limitations. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIs.

62B—Multnomah cobbly silt loam, 0 to 7 percent slopes. This deep, well drained soil is on broad terraces. It formed in alluvium. The native vegetation is mainly Douglas-fir, western hazel, salal, Oregon-grape, poison-oak, and swordfern. Elevation is 100 to 200 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown cobbly silt loam about 8 inches thick. The subsoil is brown bouldery silt loam about 22 inches thick. The substratum to a depth of 60 inches or more is brown very bouldery loamy sand.

Included in this unit are small areas of Salem soils and Rock outcrop. Included areas make up about 15 percent of the total acreage.

Permeability of this Multnomah soil is moderate to a depth of 30 inches and rapid below this depth. Available water capacity is about 4.5 to 6.5 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used mainly for homesite development. It is also used as wildlife habitat and for timber production. The unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Multnomah soils that have been cut or graded.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 150. On the basis of a site index of 145, the potential production per acre of merchantable timber is 9,120 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 82,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the low available water capacity of the soil. Conventional methods of harvesting timber can be used. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the high content of cobbles and boulders and the low available water capacity of the soil. The cobbles and boulders in the subsoil interfere with excavation for installing utilities. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIs.

63B—Multorpor very cobbly loamy sand, 0 to 8 percent slopes. This deep, excessively drained soil is on flood plains along high gradient streams at the base of steep, mountainous areas. It formed in mixed alluvium. The vegetation in areas not cultivated is mainly lodgepole pine, western hemlock, manzanita, red alder, lichens, and moss. Elevation is 500 to 2,000 feet. The average annual precipitation is 80 to 95 inches, the average annual air temperature is 45 to 48 degrees F, and the average frost-free period is 80 to 130 days.

Typically, the surface layer is very dark gray very cobbly loamy sand about 5 inches thick. The subsoil is variegated dark grayish brown, grayish brown, and very dark grayish brown very cobbly coarse sand about 8

inches thick. The substratum to a depth of 60 inches or more is very dark gray extremely stony coarse sand.

Included in this unit are small areas of Crutch soils and Riverwash. Included areas make up about 15 percent of the total acreage.

Permeability of this Multorpor soil is rapid. Available water capacity is about 2 to 3 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. This soil is subject to brief periods of flooding in winter. The soil is droughty in summer.

This unit is used as wildlife habitat, recreation, and homesites.

If this unit is used for homesite development, the main limitations are the periods of flooding and the high content of coarse fragments. The large cobbles and stones in the subsoil interfere with excavation for installing utilities. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Septic tank absorption fields do not function properly during the periods of flooding.

This map unit is in capability subclass VIIw.

64B—Nekia silty clay loam, 2 to 8 percent slopes. This moderately deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from basalt. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, shrubs, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 51 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silty clay loam about 9 inches thick. The upper 10 inches of the subsoil is dark brown silty clay loam, and the lower 20 inches is dark reddish brown clay and gravelly clay. Basalt is at a depth of 39 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are small areas of Saum, Witzel, and Jory soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Nekia soil is moderately slow. Available water capacity is about 4 to 7 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used mainly for crops such as small grain, hay, and pasture. Orchard crops and berries are also grown. Some areas of the unit are used for timber production and as homesites and wildlife habitat.

If this unit is used for cultivated crops, the main limitation is the restricted rooting depth. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and berries respond to nitrogen, phosphorus, and potassium.

If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling and subsoiling can be used to break up the pan.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 155. On the basis of a site index of 152, the potential production per acre of merchantable timber is 9,660 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 88,480 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

The main limitations of the unit for use as homesites are depth to rock, the moderately slow permeability, low soil strength, and the potential for shrinking and swelling. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

Because of the depth to rock and the moderately slow permeability, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

This map unit is in capability subclass IIe.

64C—Nekia silty clay loam, 8 to 15 percent slopes. This moderately deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from basalt. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, shrubs, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 51 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silty clay loam about 9 inches thick. The upper 10 inches of the subsoil is dark brown silty clay loam, and the lower 20 inches is dark reddish brown clay and gravelly clay.

Basalt is at a depth of 39 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are small areas of Saum, Witzel, and Jory soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Nekia soil is moderately slow. Available water capacity is about 4 to 7 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used mainly for crops such as hay, pasture, and small grain. Orchard crops and berries are also grown. Some areas of the unit are used for timber production and as homesites and wildlife habitat.

If this unit is used for cultivated crops, the main limitations are the restricted rooting depth and slope. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and berries respond to nitrogen, phosphorus, and potassium.

If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. A tillage pan forms easily if the soil in this unit is tilled when wet. Chiseling and subsoiling can be used to break up the pan.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 155. On the basis of a site index of 152, the potential production per acre of merchantable timber is 9,660 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 88,480 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

The main limitations of this unit for use as homesites are depth to bedrock, the moderately slow permeability, low soil strength, and the potential for shrinking and swelling. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

Because of the depth to rock and the moderately slow permeability, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

This map unit is in capability subclass IIIe.

64D—Nekia silty clay loam, 15 to 30 percent slopes. This moderately deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from basalt. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, shrubs, and grasses. Elevation is 250 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 51 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silty clay loam about 9 inches thick. The upper 10 inches of the subsoil is dark brown silty clay loam, and the lower 20 inches is dark reddish brown clay and gravelly clay. Basalt is at a depth of 39 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are small areas of Saum, Witzel, and Jory soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Nekia soil is moderately slow. Available water capacity is about 4 to 7 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is rapid, and the hazard of water erosion is severe. This soil is droughty in summer.

This unit is used mainly for pasture. It is also used for timber production and as homesites and wildlife habitat.

If this unit is used for pasture, the main limitation is steepness of slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 155. On the basis of a site index of 148, the potential production per acre of merchantable timber is 9,360 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 84,880 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is steepness of slope. Slope limits the kinds of equipment that can be used in forest management. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

The main limitations of this unit for use as homesites are slope, depth to rock, the moderately slow permeability, low soil strength, and the potential for shrinking and swelling. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Preserving the existing plant cover during construction helps to control erosion.

Because of the depth to rock and the moderately slow permeability, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

This map unit is in capability subclass IVe.

65F—Newanna-Rock outcrop complex, 60 to 90 percent slopes. This map unit is on headwalls of mountainous uplands. The native vegetation is mainly noble fir, silver fir, mountain hemlock, rhododendron, big huckleberry, and beargrass. Elevation is 3,800 to 5,000 feet. The average annual precipitation is 90 to 110 inches, the average annual air temperature is 38 to 42 degrees F, and the average frost-free period is 10 to 30 days.

This unit is 50 percent Newanna very gravelly loam and 25 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Talapus, Thader, and Lastance soils and Cryochrepts. Included areas make up about 25 percent of the total acreage.

The Newanna soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is dark brown very gravelly loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown very gravelly loam, and the lower 13 inches is brown extremely cobbly loam. Fractured andesite is at a depth of 28 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Newanna soil is moderate. Available water capacity is about 2 to 5 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of basalt or andesite. Some areas are nearly perpendicular cliffs as much as 100 feet high. Other areas are columns of rock as much as 200 feet in diameter and 100 feet high.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is poorly suited to the production of noble fir. On the Newanna soil, the site index for noble fir ranges from 70 to 85. On the basis of a site index of 80, the potential production per acre of merchantable timber is 3,800 cubic feet from an even-aged, fully stocked stand of trees 70 years old or 14,750 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 100 years old.

The main concerns in producing and harvesting timber are steepness of slope, Rock outcrop, cold soil temperatures, and the content of rock fragments. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used for harvesting timber. Use of these methods is limited during December through April because of a deep accumulation of snow. The areas of Rock outcrop make felling and yarding difficult. Landsliding and slumping can result where roads are constructed. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills.

Timber production is low on this unit because of cold soil temperatures. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Trees commonly are subject to windthrow during periods when the soil is excessively wet and winds are strong. Brushy plants such as rhododendron and big huckleberry limit natural regeneration of noble fir.

This map unit is in capability subclass VIIs.

66D—Newanna-Thader complex, 5 to 30 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly noble fir, silver fir, mountain hemlock, rhododendron, big huckleberry, and beargrass. Elevation is 3,800 to 5,000 feet. The average annual precipitation is 90 to 110 inches, the average annual air temperature is 38 to 42 degrees F, and the average frost-free period is 10 to 30 days.

This unit is 55 percent Newanna very gravelly loam and 25 percent Thader very cobbly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Talapus and Lastance soils. Also included are small areas of Rock outcrop and Cryochrepts. Included areas make up about 20 percent of the total acreage.

The Newanna soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is dark brown very gravelly loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown very gravelly loam, and the lower 13 inches is brown extremely cobbly loam. Fractured andesite is at a depth of 28 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Newanna soil is moderate. Available water capacity is about 2 to 5 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is medium, and the hazard of water erosion is moderate.

The Thader soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite

and basalt mixed with volcanic ash. Typically, the surface layer is dark gray very cobbly loam about 2 inches thick. The subsoil is dark reddish brown, dark brown, and brown very cobbly loam 21 inches thick. Fractured bedrock is at a depth of 23 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Thader soil is moderately rapid. Available water capacity is about 1 to 4 inches. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of noble fir. On the Newanna soil, the site index for noble fir ranges from 70 to 82. On the basis of a site index of 75, the potential production per acre of merchantable timber is 3,710 cubic feet from an even-aged, fully stocked stand of trees 70 years old or 27,610 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 110 years old.

On the Thader soil, the site index for noble fir ranges from 50 to 70. On the basis of a site index of 60, the potential production per acre of merchantable timber is 2,380 cubic feet from an even-aged, fully stocked stand of trees 70 years old or 13,970 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 110 years old.

The main concerns in producing and harvesting timber are cold soil temperatures, the content of rock fragments, and the acidity of the soils. Conventional methods of harvesting timber generally are suitable, but the soils may be compacted if heavy equipment is used while the soils are wet. Logging may be restricted during December through April because of a deep accumulation of snow. Roads and landings are protected from erosion by constructing water bars and by seeding cuts and fills.

Timber production is low on this unit because of cold soil temperatures and the acidity of the soils. Trees commonly are subject to windthrow during periods when the soil is excessively wet and winds are strong. Droughtiness caused by coarse fragments in the soils reduces seedling survival. Brushy plants such as rhododendron and big huckleberry limit natural regeneration of noble fir.

This map unit is in capability subclass VIIs.

66E—Newanna-Thader complex, 30 to 60 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly noble fir, silver fir, mountain hemlock, rhododendron, big huckleberry, and beargrass. Elevation is 3,800 to 5,000 feet. The average annual precipitation is 90 to 110 inches, the average annual air temperature is 38 to 42 degrees F, and the average frost-free period is 10 to 30 days.

This unit is 55 percent Newanna very gravelly loam and 20 percent Thader very cobbly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Talapus and Lastance soils. Also included are small areas of Rock outcrop and Cryochrepts. Included areas make up about 25 percent of the total acreage.

The Newanna soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is dark brown very gravelly loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown very gravelly loam, and the lower 13 inches is brown extremely cobbly loam. Fractured andesite is at a depth of 28 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Newanna soil is moderate. Available water capacity is about 2 to 5 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is rapid, and the hazard of water erosion is severe.

The Thader soil is moderately deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is dark gray very cobbly loam about 2 inches thick. The subsoil is dark reddish brown, dark brown, and brown very cobbly loam 21 inches thick. Fractured bedrock is at a depth of 23 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Thader soil is moderately rapid. Available water capacity is about 1 to 4 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of noble fir. On the Newanna soil, the site index for noble fir ranges from 70 to 82. On the basis of a site index of 75, the potential production per acre of merchantable timber is 3,710 cubic feet from an even-aged, fully stocked stand of trees 70 years old or 27,610 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 110 years old.

On the Thader soil, the site index for noble fir ranges from 50 to 70. On the basis of a site index of 60, the potential production per acre of merchantable timber is 2,380 cubic feet from an even-aged, fully stocked stand of trees 70 years old or 13,970 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 110 years old.

The main concerns in producing and harvesting timber are steepness of slope, cold soil temperatures, and the content of rock fragments. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used for harvesting timber. Use of these methods is limited during December through April because of a

deep accumulation of snow. Roads and landings are protected from erosion by constructing water bars and by seeding cuts and fills.

Timber production is low on this unit because of cold soil temperatures and the acidity of the soils. Trees commonly are subject to windthrow during periods when the soil is excessively wet and winds are strong. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Brushy plants such as rhododendron and huckleberry limit natural regeneration of noble fir.

This map unit is in capability subclass VIIs.

67—Newberg fine sandy loam. This deep, somewhat excessively drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, black cottonwood, Oregon ash, Oregon white oak, willows, trailing blackberry, shrubs, and grasses. Elevation is 30 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown fine sandy loam about 14 inches thick. The next layer is dark yellowish brown fine sandy loam about 9 inches thick. The upper 19 inches of the substratum is dark grayish brown fine sand, and the lower part to a depth of 60 inches or more is brown and dark brown very gravelly sand. Some areas of similar included soils do not have a layer of very gravelly sand.

Included in this unit are small areas of Cloquato, McBee, Chehalis, Wapato, and Camas soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Newberg soil is moderately rapid. Available water capacity is about 6 to 8 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight except during periods of flooding. This soil is subject to brief periods of flooding in winter. The soil is droughty in summer.

Most areas of this unit are used for cultivated crops, mainly corn, beans, wheat, filberts, and alfalfa. Among the other crops grown are berries, pasture, and nursery stock. Some areas are used for timber production, wildlife habitat, and recreation.

This unit is suited to cultivated crops. It is limited mainly by the brief periods of flooding and droughtiness. The risk of flooding is reduced by the use of levees, dikes, and diversions. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Because the soil is droughty, applications of irrigation water should be light and frequent. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 140 to 150. On the basis of a site index of 147, the potential production per acre of merchantable timber is 9,240 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 83,920 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are brush competition and the brief periods of flooding. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Seedling mortality is a concern because of the periods of flooding. Conventional methods of harvesting timber generally are suitable on this unit, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads on this unit need heavy base rock for year-round use. Brushy plants such as trailing blackberry, willow, and Oregon ash limit natural regeneration of Douglas-fir.

This map unit is in capability subclass IIw.

68—Newberg loam. This deep, somewhat excessively drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Douglas-fir, black cottonwood, Oregon ash, Oregon white oak, willows, blackberries, shrubs, and grasses. Elevation is 30 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 14 inches thick. The next layer is dark yellowish brown fine sandy loam about 9 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown sand. In some areas very gravelly sand is below a depth of 40 inches.

Included in this unit are small areas of Cloquato, Chehalis, McBee, Wapato, and Camas soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Newberg soil is moderately rapid. Available water capacity is about 7 to 9 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight except during periods of flooding. This soil is subject to brief periods of flooding in winter. The soil is droughty in summer.

This unit is used mainly for crops such as wheat, sweet corn, beans, and hay. Among the other crops grown are pasture, berries and orchard crops. Some areas of the unit are used as wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by the brief periods of flooding. The risk of flooding is reduced by the use of levees, dikes, and diversions. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable

method of applying water. Applications of irrigation water should be light and frequent. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If root crops are harvested when the soil in this unit is wet, the soil is subject to compaction.

This map unit is in capability subclass IIw.

69—Pits. This map unit is throughout the survey area. It consists of open excavations from which the soil and commonly some of the underlying material such as hard rock or gravel have been removed. The pits in upland areas are sources of rock. The ones on terraces or flood plains are sources of gravel or topsoil, or both. Many of the abandoned gravel pits on flood plains and low terraces are filled at least partially with water and are stocked with fish. Many other pits are filled by industrial waste, by material that has slumped from road cutbanks, or by debris from ditches.

This map unit is not assigned a capability classification.

70B—Powell silt loam, 0 to 8 percent slopes. This deep, somewhat poorly drained soil is on high terraces. It formed in silty material over old silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, red alder, bigleaf maple, salal, rose, shrubs, and grasses. Elevation is 300 to 600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The upper 5 inches of the subsoil is dark brown and dark yellowish brown silt loam, and the lower 3 inches is mottled, dark brown silt loam. Below this to a depth of 60 inches or more is a brown, dark grayish brown, very dark grayish brown, and yellowish brown silt loam hardpan.

Included in this unit are small areas of Cascade, Kinton, Delena, and Hardscrabble soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Powell soil is moderate to a depth of 15 inches and slow below this depth. Available water capacity is about 3.5 to 6.0 inches. Effective rooting depth is restricted by the depth to the hardpan. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 18 to 24 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as hay, pasture, strawberries, and small grain. It is also used as homesites and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by wetness and the restricted rooting depth. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile systems are difficult to install because of the depth to the hardpan; they should be installed across the slope. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed.

If this unit is used for homesite development, the main limitations are wetness, the slow permeability, and low soil strength. Drainage is needed if roads and buildings are constructed. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

Because of the depth to the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

It is difficult to establish plants in areas where the upper part of the soil has been removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIIw.

70C—Powell silt loam, 8 to 15 percent slopes. This deep, somewhat poorly drained soil is on high terraces. It formed in silty material over old silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, red alder, bigleaf maple, vine maple, salal, rose, shrubs, and grasses. Elevation is 300 to 600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The upper 5 inches of the subsoil is dark brown and dark yellowish brown silt loam, and the lower 3 inches is mottled, dark brown silt loam. Below this to a depth of 60 inches or more is a brown, dark grayish brown, very dark grayish brown, and yellowish brown silt loam hardpan.

Included in this unit are small areas of Cascade, Kinton, Delena, and Hardscrabble soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Powell soil is moderate to a depth of 15 inches and slow below this depth. Available water capacity is about 3.5 to 6.0 inches. Effective rooting depth is restricted by the depth to the hardpan. Runoff is medium, and the hazard of water erosion is moderate.

The water table is at a depth of 18 to 24 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, and small grain. Strawberries are also grown. Some areas of the unit are used as homesites, and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by wetness, the restricted rooting depth, and slope. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile systems are difficult to install because of the depth to the hardpan. They should be installed across the slope. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

If this unit is used for homesite development, the main limitations are wetness, the slow permeability, low soil strength, and slope. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

Slope is a concern in installing septic tank absorption fields. Because of the depth to the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

It is difficult to establish plants in areas where the upper part of the soil has been removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIIe.

70D—Powell silt loam, 15 to 30 percent slopes. This deep, somewhat poorly drained soil is on high terraces and rolling uplands. It formed in silty material over old silty alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, red alder, bigleaf maple, vine maple, salal, rose, shrubs, and grasses. Elevation is 300 to 600 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The upper 5 inches of the subsoil is dark brown and dark yellowish brown silt loam, and the lower 3 inches is mottled, dark brown silt loam. Below this to a depth of 60 inches or more is a brown, dark grayish brown, very dark grayish brown, and yellowish brown silt loam hardpan.

Included in this unit are small areas of Cascade, Kinton, and Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Powell soil is moderate to a depth of 15 inches and slow below this depth. Available water capacity is about 3.5 to 6.0 inches. Effective rooting depth is restricted by the depth to the hardpan. Runoff is medium, and the hazard of water erosion is severe. The water table is at a depth of 18 to 24 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for pasture and hay. It is also used as homesites and wildlife habitat.

If this unit is used for hay and pasture, the main limitation is steepness of slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

If this unit is used for homesite development, the main limitations are wetness, the slow permeability, low soil strength, and slope. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load.

It is difficult to establish plants in areas where the upper part of the soil has been removed, exposing the hardpan. Mulch and fertilizer help to establish plants in cut areas. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

Slope is a concern in installing septic tank absorption fields. Because of the depth to the hardpan, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

This map unit is in capability subclass IVe.

71A—Quatama loam, 0 to 3 percent slopes. This deep, moderately well drained soil is on terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, Oregon white oak, ash, Oregon-grape, grasses, and forbs. Elevation is 100 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 8 inches thick. The upper 10 inches of the subsoil is dark yellowish brown loam, and the lower 20 inches is dark yellowish brown clay loam. The substratum to a depth of 60 inches or more is dark yellowish brown loam.

Included in this unit are small areas of Aloha, Latourell, and Delena soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Quatama soil is moderately slow. Available water capacity is about 8 to 10 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly small grain and strawberries. Among the other crops grown are nursery stock, vegetables, filberts, hay, and pasture. Some areas are used as homesites and wildlife habitat and for recreational development. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 75 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Quatama soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by wetness. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop.

If this unit is used for homesite development, the main limitations are wetness, low soil strength, and the moderately slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIw.

71B—Quatama loam, 3 to 8 percent slopes. This deep, moderately well drained soil is on terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, Oregon white oak, ash, Oregon-grape, grasses, and forbs. Elevation is 100 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 8 inches thick. The upper 10 inches of the subsoil is dark yellowish brown loam, and the lower 20 inches is dark yellowish brown clay loam. The substratum to a depth of 60 inches or more is dark yellowish brown loam.

Included in this unit are small areas of Aloha, Delena, and Latourell soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Quatama soil is moderately slow. Available water capacity is about 8 to 10 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly small grain and strawberries. Among the other crops grown are nursery stock, vegetables, filberts, hay, and pasture. Some areas are used as homesites and wildlife habitat and for recreational development. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 75 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Quatama soils that have been cut or graded.

This unit is well suited to cultivated crops. It is limited mainly by wetness. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed.

If this unit is used for homesite development, the main limitations are wetness, low soil strength, and the moderately slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy

periods because of wetness and the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIe.

71C—Quatama loam, 8 to 15 percent slopes. This deep, moderately well drained soil is on terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, Oregon white oak, ash, Oregon-grape, grasses, and forbs. Elevation is 100 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown loam about 8 inches thick. The upper 10 inches of the subsoil is dark yellowish brown loam, and the lower 20 inches is dark yellowish brown clay loam. The substratum to a depth of 60 inches or more is dark yellowish brown loam.

Included in this unit are small areas of Aloha and Latourell soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Quatama soil is moderately slow. Available water capacity is about 8 to 10 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as small grain, hay, and pasture. It is also used as homesites and wildlife habitat and for recreational development.

This unit is suited to cultivated crops. It is limited mainly by wetness and slope. Wetness generally limits the suitability of this unit for deep-rooted crops. Crops that require good drainage can be grown if a properly designed tile system is installed. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

If this unit is used for homesite development, the main limitations are wetness, slope, low soil strength, and the moderately slow permeability. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion.

Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Slope is a concern in installing septic tank absorption fields.

In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIIe.

72D—Ritner cobbly silty clay loam, 5 to 30 percent slopes. This moderately deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from basalt. The native vegetation is mainly Douglas-fir, Oregon white oak, poison-oak, western hazel, trailing blackberry, snowberry, and swordfern. Elevation is 400 to 1,800 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is 49 to 54 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is dark brown cobbly silty clay loam about 6 inches thick. The subsoil is brown and reddish brown very cobbly silty clay loam about 20 inches thick. Fractured bedrock is at a depth of 26 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are small areas of Nekia, Witzel, Saum, and Hardscrabble soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Ritner soil is moderately slow. Available water capacity is about 2.5 to 6.0 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used for pasture, homesites, timber production, and wildlife habitat.

If this unit is used for pasture, the main limitations are the content of rock fragments and the low available water capacity of the soil. The use of equipment is limited by cobbles on the surface and by slope. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 130 to 150. On the basis of a site index of 135, the potential production per acre of merchantable timber is 8,280 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 72,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the low available water capacity of the soil. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and poison-oak limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are depth to rock, the content of rock fragments, and the moderately slow permeability. The limited depth to bedrock interferes with excavation for utilities and septic tank absorption fields. Cuts needed to provide essentially level building sites can expose bedrock. Roads and buildings should be designed to offset the effects of shrinking and swelling. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass VIs.

72E—Ritner cobbly silty clay loam, 30 to 60 percent slopes. This moderately deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from basalt. The native vegetation is mainly Douglas-fir, Oregon white oak, poison-oak, western hazel, trailing blackberry, snowberry, and swordfern. Elevation is 400 to 1,800 feet. The average annual precipitation is 45 to 60 inches, the average annual air temperature is 49 to 54 degrees F, and the average frost-free period is 160 to 210 days.

Typically, the surface layer is dark brown cobbly silty clay loam about 6 inches thick. The subsoil is brown and reddish brown very cobbly silty clay loam about 20 inches thick. Fractured bedrock is at a depth of 26 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are small areas of Witzel and Saum soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Ritner soil is moderately slow. Available water capacity is about 2.5 to 6.0 inches. Effective rooting depth is restricted by the depth to bedrock. Runoff is rapid, and the hazard of water erosion is severe. This soil is droughty in summer.

This unit is used for timber production and as wildlife habitat.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 130 to 150. On the basis of a site index of 135, the potential production per acre of merchantable timber is 8,280 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 72,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are slope and the low available water capacity of the soil. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used for harvesting timber. Use of these methods should be limited during December through March to prevent damage to the saturated soil. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Brushy plants such as western hazel and poison-oak limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIIs.

73—Riverwash. Riverwash consists of cobbles, stones, gravel, and sand in narrow, irregular strips along the major streams and rivers in the survey area. The strips are 0 to 10 feet above the water level of the rivers and streams, and they range from 20 to 200 yards wide. Riverwash is 40 inches thick to several feet thick. Slope is 0 to 3 percent.

Riverwash supports little if any vegetation. It is subject to overflow when the water level is high, and it is extremely droughty when the water level is low. During each period of overflow, material is deposited or removed.

Riverwash is used as wildlife habitat, for recreation, and as a source of gravel.

This map unit is in capability subclass VIIIw.

74F—Rock outcrop-Cryochrepts complex, very steep. This map unit is on headwalls and ridgetops of high mountainous uplands. Slope is 30 to 90 percent. The native vegetation is mainly rhododendron, beargrass, and scattered Douglas-fir and noble fir. Elevation is 2,800 to 5,000 feet. The average annual precipitation is 75 to 100 inches, the average annual air temperature is 38 to 44 degrees F, and the average frost-free period is 10 to 45 days.

This unit is 45 percent Rock outcrop and 40 percent Cryochrepts. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Newanna, Thader, and Highcamp soils. Included areas make up about 15 percent of the total acreage.

Rock outcrop consists of exposures of basalt and andesite. Some areas are nearly perpendicular cliffs as much as 100 feet high. Other areas are columns of rock as much as 150 feet in diameter and 100 feet high.

The Cryochrepts are shallow to moderately deep and are well drained. They formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. No single profile of Cryochrepts is typical, but one commonly observed in the survey area has a surface layer of dark brown cobbly loam about 2 inches thick.

The subsoil is brown gravelly loam about 13 inches thick. Bedrock is at a depth of 15 inches. Depth to bedrock ranges from 10 to 30 inches.

Permeability of the Cryochrepts is moderately rapid. Available water capacity is about 1 to 4 inches. Effective rooting depth is 10 to 30 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as wildlife habitat and for recreation.

This map unit is in capability subclass VIIs.

75—Rubble land. Rubble land is mainly talus, cobbles, stones, and boulders. It generally is at the base of cliffs on steep mountainous uplands. Elevation is 1,000 to 5,000 feet. Slope is 30 to 90 percent.

This unit is used as wildlife habitat and for recreation.

This map unit is in capability subclass VIIIs.

76B—Salem silt loam, 0 to 7 percent slopes. This deep, well drained soil is on stream terraces. It formed in alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western redcedar, western hazel, Oregon-grape, salal, brackenfern, and grasses. Elevation is 200 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is dark brown gravelly silty clay loam and gravelly clay loam about 16 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown very gravelly loamy sand. Depth to the very gravelly substratum ranges from 20 to 36 inches. In some areas of similar included soils, the surface layer is gravelly silt loam.

Included in this unit are small areas of Clackamas, Coburg, and Malabon soils and Willamette soils that have a gravelly substratum. Included areas make up about 15 percent of the total acreage.

Permeability of this Salem soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 24 to 36 inches. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, and grain. Vegetables are also grown. Some areas of the unit are used for timber production and as homesites and wildlife habitat. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Salem soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by droughtiness and the restricted rooting depth. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Because the soil in this unit is droughty, applications of irrigation water should be light and frequent.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

This unit has few limitations for homesite development. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIs.

76C—Salem silt loam, 7 to 12 percent slopes. This deep, well drained soil is on stream terraces. It formed in alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western redcedar, western hazel, Oregon-grape, salal, brackenfern, and grasses. Elevation is 200 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is dark brown

gravelly silty clay loam and gravelly clay loam about 16 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown very gravelly loamy sand. Depth to the very gravelly substratum ranges from 20 to 36 inches. In some areas of similar included soils, the surface layer is gravelly silt loam.

Included in this unit are small areas of Clackamas soils and Willamette soils that have a gravelly substratum. Included areas make up about 10 percent of the total acreage.

Permeability of this Salem soil is moderate. Available water capacity is about 4 to 6 inches. Effective rooting depth is 24 to 36 inches. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used mainly for crops such as small grain, hay, and pasture. It is also used for timber production and as homesites and wildlife habitat.

If this unit is used for cultivated crops, the main limitations are droughtiness, the restricted rooting depth, and slope. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Because the soil in this unit is droughty, applications of irrigation water should be light and frequent. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitation is slope. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Slope is a concern in installing septic tank absorption fields. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

77B—Salem gravelly silt loam, 0 to 7 percent slopes. This deep, well drained soil is on stream terraces. It formed in alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western redcedar, western hazel, Oregon-grape, salal, brackenfern, and grasses. Elevation is 200 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown gravelly silt loam about 8 inches thick. The subsoil is dark brown gravelly silty clay loam and gravelly clay loam about 16 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown very gravelly loamy sand. Depth to the very gravelly substratum ranges from 20 to 36 inches.

Included in this unit are small areas of Clackamas and Coburg soils and Willamette soils that have a gravelly substratum. Included areas make up about 10 percent of the total acreage.

Permeability of this Salem soil is moderate. Available water capacity is about 3 to 5 inches. Effective rooting depth is 24 to 36 inches. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, and small grain. It is also used for timber production and as homesites and wildlife habitat.

If this unit is used for cultivated crops, the main limitations are the content of rock fragments, droughtiness, and the restricted rooting depth. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Because the soil in this unit is droughty, applications of irrigation water should be light and frequent. The content of gravel interferes with some types of tillage equipment. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

This unit has few limitations for homesite development. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIs.

78B—Saum silt loam, 3 to 8 percent slopes. This deep, well drained soil is on rolling uplands. It formed in silty material and colluvium derived dominantly from basalt. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, poison-oak, and grasses. Elevation is 250 to 800 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam and silty clay loam about 15 inches thick. The upper 11 inches of the subsoil is dark reddish brown silty clay loam, and the lower 9 inches is reddish brown gravelly silty clay loam. The substratum is yellowish red gravelly silty clay loam about 15 inches thick. Basalt is at a depth of 50 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Nekia, Jory, Witzel, Hardscrabble, and Laurelwood soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Saum soil is moderately slow. Available water capacity is about 6 to 8 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used mainly for pasture, hay, and timber production. It is also used for cultivated crops such as small grain and berries and as homesites, recreation areas, and wildlife habitat. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 50 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Saum soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by low soil fertility and by acidity. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and berries respond to nitrogen, phosphorus, and potassium.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 125 to 145. On the basis of a site index of 135, the potential production per acre of merchantable timber is 8,280 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 72,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the moderately slow permeability, a potential for shrinking and swelling, and low soil strength. Preserving the existing plant cover during construction helps to control erosion. If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling.

This map unit is in capability subclass IIe.

78C—Saum silt loam, 8 to 15 percent slopes. This deep, well drained soil is on rolling uplands. It formed in silty material and colluvium derived dominantly from basalt. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, poison-oak, and grasses. Elevation is 250 to 800 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam and silty clay loam about 15 inches thick. The upper 11 inches of the subsoil is dark reddish brown silty clay loam, and the lower 9 inches is reddish brown gravelly silty clay loam. The substratum is yellowish red gravelly silty clay loam about 15 inches thick. Basalt is at a depth of 50 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Nekia, Jory, Witzel, Hardscrabble, and Laurelwood soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Saum soil is moderately slow. Available water capacity is about 6 to 8 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used mainly for pasture, hay, and timber production. It is also used for cultivated crops such as small grain and as homesites and wildlife habitat.

This unit is suited to cultivated crops. It is limited mainly by slope, low soil fertility, and acidity. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 125 to 145. On the basis of a site index of 135, the potential production per acre of merchantable timber is 8,280 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 72,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slope, the moderately slow permeability, a potential for shrinking and swelling, and low soil strength. Preserving the existing plant cover during construction helps to control erosion. If the unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling.

This map unit is in capability subclass IIIe.

78D—Saum silt loam, 15 to 30 percent slopes. This deep, well drained soil is on rolling uplands. It formed in silty material and colluvium derived dominantly from basalt. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, poison-oak, and grasses. Elevation is 250 to 800 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam and silty clay loam about 15 inches thick. The upper 11 inches of the subsoil is dark reddish brown silty clay loam, and the lower 9 inches is reddish brown gravelly silty clay loam. The substratum is yellowish red gravelly silty clay loam about 15 inches thick. Basalt is at a depth of 50 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Nekia, Jory, Laurelwood, and Witzel soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Saum soil is moderately slow. Available water capacity is about 6 to 8 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used mainly for timber production. It is also used for pasture and as homesites and wildlife habitat.

If this unit is used for pasture, the main limitation is steepness of slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 125 to 145. On the basis of a site index of 135, the potential production per acre of merchantable timber is 8,280 cubic feet from an even-aged, fully stocked stand of trees 60 years old or

72,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is slope. The steepness of slope limits the kinds of equipment that can be used in forest management. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

The main limitations of this unit for use as homesites are slope, the moderately slow permeability, the potential for shrinking and swelling, and low soil strength. Preserving the existing plant cover during construction helps to control erosion. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling.

If this unit is used for septic tank absorption fields, the main limitation is the moderately slow permeability. Slope is a concern in installing septic tank absorption fields.

This map unit is in capability subclass IVe.

78E—Saum silt loam, 30 to 60 percent slopes. This deep, well drained soil is on rolling uplands. It formed in silty material and colluvium derived dominantly from basalt. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, poison-oak, and grasses. Elevation is 250 to 800 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is dark brown silt loam and silty clay loam about 15 inches thick. The upper 11 inches of the subsoil is dark reddish brown silty clay loam, and the lower 9 inches is reddish brown gravelly silty clay loam. The substratum is yellowish red gravelly silty clay loam about 15 inches thick. Basalt is at a depth of 50 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are small areas of Xerochrepts, Haploxerolls, and Nekia and Witzel soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Saum soil is moderately slow. Available water capacity is about 6 to 8 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used mainly for timber production and as wildlife habitat and homesites.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 125 to 145. On the basis of a site index of 135, the potential production per acre of merchantable timber is 8,280 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 72,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is steepness of slope. Conventional methods of harvesting timber are difficult to use because of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during December through March. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are steepness of slope, the moderately slow permeability, a potential for shrinking and swelling, and low soil strength. Preserving the existing plant cover during construction helps to control erosion. This unit generally is too steep to install septic tank absorption fields. Absorption lines should be placed in adjoining areas that are more nearly level. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling.

This map unit is in capability subclass VIe.

79B—Sawtell silt loam, 0 to 8 percent slopes. This deep, moderately well drained soil is on terraces. It formed in gravelly old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, wildrose, trailing blackberry, and grasses. Elevation is 300 to 500 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The upper 7 inches of the subsoil is dark brown gravelly clay loam, and the lower 23 inches is mottled, brown very gravelly clay loam. The substratum to a depth of 60 inches or more is yellowish brown very gravelly clay. In some areas of similar included soils, the surface layer is gravelly loam.

Included in this unit are small areas of Clackamas, Dayton, Hardscrabble, and Concord soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Sawtell soil is moderately slow. Available water capacity is about 5 to 9 inches. Effective rooting depth is 40 to 50 inches. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 18 to 36 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, Christmas trees, and small grain and for homesite development. It is also used for timber production, wildlife habitat, and recreation.

If this unit is used for hay and pasture, the main limitation is wetness. When the soil is wet, grazing and other activities that cause trampling result in compaction

of the surface layer, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. Fertilizer is needed to insure optimum growth of grasses and legumes.

If this unit is used for cultivated crops, the main limitations are wetness and acidity. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 155. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are wetness and the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Trees are subject to windthrow because of the restricted rooting depth. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Droughtiness caused by coarse fragments in the soil reduces seedling survival.

If this unit is used for homesite development, the main limitations are wetness, the moderately slow permeability, and the content of rock fragments in the soil. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIw.

79C—Sawtell silt loam, 8 to 15 percent slopes. This deep, moderately well drained soil is on terraces. It formed in gravelly old alluvium. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, wild rose, trailing blackberry, and grasses. Elevation is 300 to 500 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The upper 7 inches of the subsoil is dark brown gravelly clay loam, and the lower 23 inches is mottled, brown very gravelly clay loam. The substratum to a depth of 60 inches or more is yellowish brown very gravelly clay. In some areas of similar included soils, the surface layer is gravelly loam.

Included in this unit are small areas of Clackamas, Hardscrabble, and Concord soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Sawtell soil is moderately slow. Available water capacity is about 5 to 9 inches. Effective rooting depth is 40 to 50 inches. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 18 to 36 inches in winter. This soil is droughty in summer.

This unit is used mainly for crops such as pasture, hay, and small grain and for homesite development. It is also used as wildlife habitat and for timber production and recreation.

If this unit is used for hay and pasture, the main limitations are wetness and slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. Fertilizer is needed to insure optimum growth of grasses and legumes.

If this unit is used for cultivated crops, the main limitations are slope, wetness, and acidity. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Seedbed preparation should be on the contour or across the slope where practical. Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 155. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are wetness and the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Trees are subject to windthrow because of the restricted rooting depth. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Droughtiness caused by coarse fragments in the soil reduces seedling survival.

If this unit is used for homesite development, the main limitations are wetness, slope, the moderately slow permeability, and the content of rock fragments in the soil. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. Slope is a concern in installing septic tank absorption fields. Removal of gravel and cobbles in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIIe.

80B—Springwater loam, 2 to 8 percent slopes. This moderately deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from sandstone. The native vegetation is mainly Douglas-fir, bigleaf maple, western hazel, vine maple, red huckleberry, salal, Oregon-grape, and swordfern. Elevation is 500 to 1,800 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown loam and clay loam about 15 inches thick. The upper 12 inches of the subsoil is brown clay loam, and the lower 10 inches is brown gravelly clay loam. Fractured sandstone is at a depth of 37 inches. Depth to sandstone ranges from 20 to 40 inches.

Included in this unit are small areas of Gapcot, Hardscrabble, and Saum soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Springwater soil is moderate. Available water capacity is about 4 to 9 inches. Effective rooting depth is restricted by the depth to sandstone. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

This unit is used for crops such as pasture, hay, small grain, and grass seed; as homesites and wildlife habitat; and for timber production.

This unit is suited to hay and pasture. It has few limitations. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to cultivated crops. It has few limitations. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Maintaining crop residue on or near the surface reduces runoff and helps to maintain soil tilth and organic matter content.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Trees are subject to windthrow because of the restricted rooting depth. Brushy plants such as western hazel and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the depth to bedrock and low soil strength. The limited depth to bedrock interferes with excavation for utilities and septic tank absorption fields. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIIe.

80C—Springwater loam, 8 to 15 percent slopes. This moderately deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from sandstone. The native vegetation is mainly Douglas-fir, bigleaf maple, western hazel, vine maple, red huckleberry, salal, Oregon-grape, and swordfern. Elevation is 500 to 1,800 feet. The average annual precipitation is 50 to 60 inches, the average annual air

temperature is 48 to 52 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown loam and clay loam about 15 inches thick. The upper 12 inches of the subsoil is brown clay loam, and the lower 10 inches is brown gravelly clay loam. Fractured sandstone is at a depth of 37 inches. Depth to sandstone ranges from 20 to 40 inches.

Included in this unit are small areas of Gapcot, Hardscrabble, and Saum soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Springwater soil is moderate. Available water capacity is about 4 to 9 inches. Effective rooting depth is restricted by the depth to sandstone. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used for crops such as pasture, hay, small grain, and grass seed; as homesites and wildlife habitat; and for timber production.

If this unit is used for hay and pasture, the main limitation is slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

If this unit is used for cultivated crops, the main limitation is slope. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation can be used, but water needs to be applied slowly to minimize runoff. Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Trees are subject to windthrow because of the restricted rooting depth. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the depth to bedrock, slope, and low soil strength. The limited depth to bedrock interferes with excavation for utilities and septic tank absorption fields. Cuts needed to provide essentially level building sites can expose bedrock. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IVe.

80D—Springwater loam, 15 to 30 percent slopes. This moderately deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from sandstone. The native vegetation is mainly Douglas-fir, bigleaf maple, western hazel, vine maple, red huckleberry, salal, Oregon-grape, and swordfern. Elevation is 500 to 1,800 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown loam and clay loam about 15 inches thick. The upper 12 inches of the subsoil is brown clay loam, and the lower 10 inches is brown gravelly clay loam. Fractured sandstone is at a depth of 37 inches. Depth to sandstone ranges from 20 to 40 inches.

Included in this unit are small areas of Gapcot and Saum soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Springwater soil is moderate. Available water capacity is about 4 to 9 inches. Effective rooting depth is restricted by the depth to sandstone. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used for crops such as pasture and grass seed, for timber production, and as homesites and wildlife habitat.

If this unit is used for pasture, the main limitation is slope. Seedbed preparation should be on the contour or across the slope where practical. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Fertilizer is needed to insure optimum growth of grasses and legumes.

If this unit is used for production of grass seed, the main limitation is slope. All tillage should be on the contour or across the slope. Tillage should be kept to a minimum. Grain and grasses respond to nitrogen, and legumes respond to phosphorus, boron, sulfur, and lime.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 155, the potential production per

acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the restricted rooting depth. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Trees are subject to windthrow because of the restricted rooting depth. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and vine maple limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the depth to rock, slope, and low soil strength. The limited depth to bedrock interferes with excavation for utilities and septic tank absorption fields. Cuts needed to provide essentially level building sites can expose bedrock. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass VIe.

80E—Springwater loam, 30 to 60 percent slopes. This moderately deep, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from sandstone. The native vegetation is mainly Douglas-fir, bigleaf maple, western hazel, vine maple, red huckleberry, salal, Oregon-grape, and swordfern. Elevation is 500 to 1,800 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 160 to 200 days.

Typically, the surface layer is dark brown loam and clay loam about 15 inches thick. The upper 12 inches of the subsoil is brown clay loam, and the lower 10 inches is brown gravelly clay loam. Fractured sandstone is at a depth of 37 inches. Depth to sandstone ranges from 20 to 40 inches.

Included in this unit are small areas of Gapcot and Saum soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Springwater soil is moderate. Available water capacity is about 4 to 9 inches. Effective rooting depth is restricted by the depth to sandstone. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production and as wildlife habitat.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 150 to 160. On the basis of a site index of 155, the potential production per acre of merchantable timber is 9,840 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 91,040 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are the restricted rooting depth and steepness of slope. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used. Use of these methods should be limited during December through March to prevent damage to the saturated soil. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Trees are subject to windthrow because of the restricted rooting depth. Brushy plants such as western hazel and vine maple limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

81D—Talapus-Lastance complex, 5 to 30 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly noble fir, western hemlock, Douglas-fir, silver fir, rhododendron, big huckleberry, and beargrass. Elevation is 3,500 to 4,800 feet. The average annual precipitation is 90 to 110 inches, the average annual air temperature is 38 to 42 degrees F, and the average frost-free period is 10 to 30 days.

This unit is 50 percent Talapus very gravelly loam and 25 percent Lastance stony fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Newanna, Thader, and Highcamp soils and Rock outcrop. Included areas make up about 25 percent of the total acreage.

The Talapus soil is deep and well drained. It formed in colluvium and glacial till mixed with volcanic ash. Typically, the surface layer is very dark brown very gravelly loam about 17 inches thick. The subsoil is dark brown and brown extremely gravelly loam about 26 inches thick. The substratum to a depth of 60 inches or more is brown extremely gravelly loam.

Permeability of the Talapus soil is moderate. Available water capacity is about 5 to 10 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

The Lastance soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt. Typically, the surface layer is gray stony fine sandy loam about 1 inch thick. The subsoil is reddish brown, dark brown, and grayish brown stony fine sandy loam about 13 inches thick. The substratum to a depth of 60 inches or more is dark brown very cobbly fine sandy loam.

Permeability of the Lastance soil is moderate. Available water capacity is 3 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of noble fir. On the Talapus soil, the site index for noble fir ranges from 85 to 115. On the basis of a site index of 98, the potential production per acre of merchantable timber is 4,860 cubic feet from an even-aged, fully stocked stand of trees 70 years old or 49,280 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 110 years old.

On the Lastance soil, the site index for noble fir ranges from 50 to 70. On the basis of a site index of 61, the potential production per acre of merchantable timber is 2,450 cubic feet from an even-aged, fully stocked stand of trees 70 years old or 14,872 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 110 years old.

The main concerns in producing and harvesting timber are cold soil temperatures, the content of rock fragments, and the acidity of the soils. Conventional methods of harvesting timber generally are suitable, but the soils may be compacted if heavy equipment is used when the soils are wet. Logging may be restricted during December through April because of a deep accumulation of snow. Roads and landings are protected from erosion by constructing water bars and by seeding cuts and fills.

Timber production is low on this unit because of the cold soil temperatures and the acidity of the soils. Trees commonly are subject to windthrow during periods when the soils are excessively wet and winds are strong. Droughtiness caused by coarse fragments in the soils reduces seedling survival. Brushy plants such as rhododendron and huckleberry limit natural regeneration of noble fir.

This map unit is in capability subclass VIIs.

81E—Talapus-Lastance complex, 30 to 60 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly noble fir, western hemlock, Douglas-fir, silver fir, rhododendron, big huckleberry, and beargrass. Elevation is 3,500 to 4,800 feet. The average annual precipitation is 90 to 110 inches, the average annual air temperature is 38 to 42 degrees F, and the average frost-free period is 10 to 30 days.

This unit is 55 percent Talapus very gravelly loam and 20 percent Lastance stony fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Newanna, Thader, and Highcamp soils and Rock outcrop. Included areas make up about 25 percent of the total acreage.

The Talapus soil is deep and well drained. It formed in colluvium and glacial till mixed with volcanic ash. Typically, the surface layer is very dark brown very gravelly loam about 17 inches thick. The subsoil is dark brown and brown extremely gravelly loam about 26 inches thick. The substratum to a depth of 60 inches or more is brown extremely gravelly loam.

Permeability of the Talapus soil is moderate. Available water capacity is about 5 to 10 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

The Lastance soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt. Typically, the surface layer is gray stony fine sandy loam about 1 inch thick. The subsoil is reddish brown, dark brown, and grayish brown stony fine sandy loam about 13 inches thick. The substratum to a depth of 60 inches or more is dark brown very cobbly fine sandy loam.

Permeability of the Lastance soil is moderate. Available water capacity is about 3 to 6 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of noble fir. On the Talapus soil, the site index for noble fir ranges from 85 to 115. On the basis of a site index of 98, the potential production per acre of merchantable timber is 4,860 cubic feet from an even-aged, fully stocked stand of trees 70 years old or 49,280 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 110 years old.

On the Lastance soil, the site index for noble fir ranges from 50 to 70. On the basis of a site index of 61, the potential production per acre of merchantable timber is 2,450 cubic feet from an even-aged, fully stocked stand of trees 70 years old or 14,872 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 110 years old.

The main concerns in producing and harvesting timber are steepness of slope, cold soil temperatures, the content of rock fragments, and the acidity of the soils. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used for harvesting timber. Use of these methods is limited during December through April because of a deep accumulation of snow. Landsliding and slumping can result where roads are constructed. Roads and landings are protected from erosion by constructing water bars and by seeding cuts and fills.

Timber production is low on this unit because of the cold soil temperatures and the acidity of the soils. Trees commonly are subject to windthrow during periods when the soils are excessively wet and winds are strong. Droughtiness caused by coarse fragments in the soils

reduces seedling survival. Brushy plants such as rhododendron and big huckleberry limit natural regeneration of noble fir.

This map unit is in capability subclass VIIs.

82—Urban land. Urban land consists of areas that are largely covered by concrete, asphalt, buildings, or other impervious surfaces that obscure or alter the soils so that identification is not feasible. The areas are on terraces and flood plains in the northwestern part of the survey area. Slope is 0 to 30 percent. Elevation is 50 to 400 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

83—Wapato silt loam. This deep, poorly drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Oregon ash, red alder, black cottonwood, willow, western redcedar, rose, rushes, sedges, and grasses. Elevation is 100 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown, mottled silt loam about 16 inches thick. The upper 16 inches of the subsoil is dark grayish brown, mottled silty clay loam, and the lower 9 inches is grayish brown, mottled silty clay. The substratum to a depth of 60 inches or more is grayish brown, mottled silty clay.

Included in this unit are small areas of Cove and McBee soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Wapato soil is moderately slow. Available water capacity is about 10 to 12 inches. Effective rooting depth is 40 to 60 inches or more for water-tolerant plants, but it is limited to depths between 20 and 30 inches for non-water-tolerant plants. Runoff is slow, and the hazard of water erosion is slight. The water table is 6 inches above the surface to a depth of 12 inches below the surface in winter. This soil is subject to brief periods of flooding from December through February.

This unit is used for crops such as hay, pasture, and vegetables; as wildlife habitat; and for recreation.

If this unit is used for hay and pasture, the main limitations are wetness and the brief periods of flooding. Wetness limits the choice of suitable plants and the period of cutting or grazing and increases the risk of winterkill. Fertilizer is needed to insure optimum growth of grasses and legumes.

If this unit is used for cultivated crops, the main limitations are wetness and the brief periods of flooding. Diversions and grassed waterways may be needed. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to phosphorus, boron, sulfur, and lime, and vegetables respond to nitrogen, phosphorus, and potassium.

This map unit is in capability subclass IIIw.

84—Wapato silty clay loam. This deep, poorly drained soil is on flood plains. It formed in mixed alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly Oregon ash, red alder, black cottonwood, willow, western redcedar, rose, rushes, sedges, and grasses (fig. 16). Elevation is 100 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown and very dark grayish brown, mottled silty clay loam about 18 inches thick. The subsoil is dark grayish brown, mottled silty clay loam about 27 inches thick. Below this to a depth of 60 inches or more is grayish brown, mottled silty clay.

Included in this unit are small areas of Cove and McBee soils and Humaquepts. Included areas make up about 15 percent of the total acreage.

Permeability of this Wapato soil is moderately slow. Available water capacity is about 10 to 12 inches. Effective rooting depth is 60 inches or more for water-tolerant plants, but it is limited to depths between 20 and 30 inches for non-water-tolerant plants. Runoff is slow, and the hazard of water erosion is slight. The water table is 6 inches above the surface to a depth of 12 inches below the surface in winter. This soil is subject to brief periods of flooding in winter.

This unit is used for crops such as hay, pasture, and vegetables; as wildlife habitat; and for recreation.

This unit is poorly suited to cultivated crops. It is limited mainly by wetness, the texture of the surface layer, and the brief periods of flooding. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer, irrigation is required for maximum production of most crops on this unit. Sprinkler irrigation is the most suitable method of applying water. Water should be applied slowly because of the texture of the surface layer.

Excessive cultivation of the soil can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur,

Figure 16.—Sedges, grasses, and Oregon ash on Wapato silty clay loam. Douglas-fir on Woodburn soils in background.

and lime; and vegetables respond to nitrogen, phosphorus, and potassium. Diversions and grassed waterways may be needed. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

This map unit is in capability subclass IIIw.

85D—Wilhoit-Zygore gravelly loams, 5 to 30 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, Oregon-grape, salal, and swordfern (fig. 17). Elevation is 1,800 to 3,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 100 days.

This unit is 60 percent Wilhoit gravelly loam and 25 percent Zygore gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Fernwood and Memaloose soils. Also included are small areas of Cryaquepts. Included areas make up about 15 percent of the total acreage.

The Wilhoit soil is deep and well drained. It formed in colluvium derived dominantly from andesite, tuff, and breccia mixed with volcanic ash. Typically, the surface layer is very dark grayish brown gravelly loam and loam about 15 inches thick. The upper 28 inches of the subsoil is dark brown loam and clay loam, and the lower 9 inches is dark brown gravelly loam. Soft, weathered tuff is at a depth of 52 inches. Depth to bedrock is 40 to 60 inches or more.

Permeability of the Wilhoit soil is moderate. Available water capacity is about 7 to 13 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

The Zygore soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is very dark grayish brown gravelly loam about 11 inches thick. The subsoil is dark brown very cobbly loam about 29 inches thick. The substratum to a depth of 60 inches

Figure 17.—Swordfern, salal, and cascade Oregon-grape on Willhoit-Zygore gravelly loams, 5 to 30 percent slopes.

or more is yellowish brown and dark yellowish brown very cobbly loam.

Permeability of the Zygore soil is moderate. Available water capacity is about 5 to 7 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. On the Wilhoit soil, the site index for Douglas-fir ranges from 130 to 170. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

On the Zygore soil, the site index for Douglas-fir ranges from 130 to 165. On the basis of a site index of 140, the potential production per acre of merchantable timber is 8,700 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 77,280 board feet

(International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

This unit has few limitations for timber production. Conventional methods of harvesting timber generally are suitable, but the soils may be compacted if heavy equipment is used when the soils are wet. Roads for year-round use need heavy base rock. Landsliding and slumping can result where roads are constructed. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as vine maple and red alder limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIe.

86A—Willamette silt loam, 0 to 3 percent slopes. This deep, well drained soil is on broad valley terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, blackberry, and grasses. Elevation is 150 to 400 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 20 inches thick. The subsoil is dark brown silt loam and silty clay loam about 38 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are small areas of Woodburn, Aloha, Amity, and Latourell soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Willamette soil is moderate. Available water capacity is about 10 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly sweet corn, bush beans, alfalfa, strawberries, and winter wheat. Among the other crops grown are filberts, spring grain, hay, pasture, and blackberries. This unit is also used for homesite development, wildlife habitat, and recreation.

This unit is suited to crops. It has few limitations. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Excessive cultivation of the soil can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are low soil strength and the moderate permeability. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability class I.

86B—Willamette silt loam, 3 to 8 percent slopes. This deep, well drained soil is on broad valley terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, blackberry, and grasses. Elevation is 150 to 400 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 20 inches thick. The subsoil is dark brown silt loam and silty clay loam about 38 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are small areas of Woodburn, Aloha, Amity, and Latourell soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Willamette soil is moderate. Available water capacity is about 10 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly alfalfa, winter wheat, sweet corn, and bush beans. Among the other crops grown are filberts, strawberries, red clover, and pasture. This unit is also used as homesites and wildlife habitat and for recreational development.

This unit is suited to crops. It has few limitations. In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Excessive cultivation of the soil can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses on this unit respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. Diversions and grassed waterways may be needed on this unit. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are low soil strength and the moderate permeability. Roads and buildings constructed on this unit should be designed to offset the limited ability of the soil to support a load. In summer, irrigation is required

for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

86C—Willamette silt loam, 8 to 15 percent slopes. This deep, well drained soil is on broad valley terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, blackberry, and grasses. Elevation is 150 to 400 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown silt loam about 20 inches thick. The subsoil is dark brown silt loam and silty clay loam about 38 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are small areas of Woodburn, Latourell, and Aloha soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Willamette soil is moderate. Available water capacity is about 10 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used mainly for cultivated crops. It is also used as homesites, wildlife habitat, and recreation areas.

This unit is suited to cultivated crops. It is limited mainly by slope. All tillage should be on the contour or across the slope. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed.

In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.

Excessive cultivation of the soil can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff.

If this unit is used for homesite development, the main limitations are slope, low soil strength, and the moderate permeability. Excavation for roads and buildings increases the risk of erosion. Preserving the existing plant cover during construction helps to control erosion. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

87A—Willamette silt loam, gravelly substratum, 0 to 3 percent slopes. This deep, well drained soil is on low terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, blackberries, and grasses. Elevation is 100 to 350 feet. The average annual precipitation is about 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown silt loam about 14 inches thick. The subsoil is dark brown silty clay loam about 22 inches thick. The substratum to a depth of 60 inches or more is brown very gravelly loam. Depth to the very gravelly substratum ranges from 35 to 40 inches.

Included in this unit are small areas of Coburg, Malabon, Clackamas, and Salem soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Willamette soil is moderate. Available water capacity is about 7 to 9 inches. Effective rooting depth is restricted by the very gravelly substratum. Runoff is slow, and the hazard of water erosion is slight. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly small grain, berries, and vegetables. Among the other crops grown are alfalfa, filberts, hay, and pasture. Some areas are used for timber production and as homesites and wildlife habitat.

This unit is suited to cultivated crops. It has few limitations. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation of the soil can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 145 to 155. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the restricted rooting depth. Conventional methods of

harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and salal limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are low soil strength and a potential for shrinking and swelling. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIs.

88A—Willamette silt loam, wet, 0 to 3 percent slopes. This deep, moderately well drained soil is on broad terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, blackberry, and native grasses. Elevation is 150 to 350 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 14 inches thick. The upper 20 inches of the subsoil is dark brown silty clay loam, and the lower 26 inches is mottled, brown silty clay loam.

Included in this unit are small areas of Woodburn, Aloha, and Quatama soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Willamette soil is moderate. Available water capacity is about 10 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 30 to 42 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly wheat, sweet corn, snap beans, and strawberries. Among the other crops grown are filberts, alfalfa, clover, potatoes, and pasture. Some areas are used as homesites and wildlife habitat and for recreational development.

This unit is suited to cultivated crops. It is limited mainly by wetness. Most climatically adapted crops can be grown if drainage is provided. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation of the soil can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitations are wetness, low soil strength, and a potential for shrinking and swelling. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIw.

88B—Willamette silt loam, wet, 3 to 7 percent slopes. This deep, moderately well drained soil is on broad terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly Douglas-fir, Oregon white oak, western hazel, blackberry, and native grasses. Elevation is 150 to 350 feet. The average annual precipitation is about 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 14 inches thick. The upper 20 inches of the subsoil is dark brown silty clay loam, and the lower 26 inches is mottled, brown silty clay loam.

Included in this unit are small areas of Woodburn, Aloha, and Quatama soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Willamette soil is moderate. Available water capacity is about 10 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 30 to 42 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly wheat, sweet corn, snap beans, and strawberries. Among the other crops grown are filberts, alfalfa, clover, potatoes, and pasture. Some areas are used as homesites and wildlife habitat and for recreational development.

This unit is suited to cultivated crops. It is limited mainly by wetness. Most climatically adapted crops can be grown if drainage is provided. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation of the soil can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. If the soil is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for homesite development, the main limitations are wetness, low soil strength, and a potential for shrinking and swelling. Wetness is reduced by installing drain tile around footings. Septic tank absorption fields do not function properly during rainy periods because of wetness. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load and to offset the effects of shrinking and swelling. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass IIe.

89D—Witzel very stony silt loam, 3 to 40 percent slopes. This shallow, well drained soil is on rolling uplands. It formed in colluvium derived dominantly from basalt. The vegetation in areas not cultivated is mainly Oregon white oak, poison-oak, Oregon-grape, grasses, and scattered Douglas-fir. Elevation is 300 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown very stony silt loam about 4 inches thick. The subsoil is dark brown very stony silty clay loam about 12 inches thick. Fractured basalt is at a depth of 16 inches. Depth to basalt ranges from 12 to 20 inches.

Included in this unit are small areas of Saum and Nekia soils, Rock outcrop, Haploxerolls, and Xerochrepts. Included areas make up about 20 percent of the total acreage.

Permeability of this Witzel soil is moderately slow. Available water capacity is about 1 to 3 inches. Effective rooting depth is restricted by the depth to basalt. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

This unit is used for timber production and as homesites and wildlife habitat.

This unit is poorly suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 110 to 120. On the basis of a site index of 115, the potential production per acre of merchantable timber is 6,360 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 57,960 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are the restricted rooting depth, stones, and droughtiness. Trees are subject to windthrow because of the restricted rooting depth. Droughtiness caused by coarse fragments in the soil reduces seedling survival. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as poison-oak and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the depth to bedrock and slope. Cuts needed to provide essentially level building sites can expose bedrock. The limited depth to bedrock interferes with excavation for utilities and septic tank absorption fields. Preserving the existing plant cover during construction helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

This map unit is in capability subclass VIIs.

90F—Witzel-Rock outcrop complex, 50 to 75 percent slopes. This map unit is on rolling uplands. The native vegetation is mainly Oregon white oak, Douglas-fir, western hazel, brackenfern, and grasses. Elevation is 600 to 2,000 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 200 days.

This unit is 45 percent Witzel very stony silt loam and 40 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Klickitat and Kinney soils. Included areas make up about 15 percent of the total acreage.

The Witzel soil is shallow and well drained. It formed in colluvium derived dominantly from basalt. Typically, the surface layer is very dark brown very stony silt loam about 4 inches thick. The subsoil is dark brown very stony silty clay loam about 12 inches thick. Basalt is at a depth of 16 inches. Depth to basalt ranges from 12 to 20 inches.

Permeability of the Witzel soil is moderately slow. Available water capacity is about 1 to 3 inches. Effective rooting depth is restricted by the depth to basalt. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of basalt and andesite. Some areas are nearly perpendicular cliffs as much as 100 feet high. Other areas are columns of rock as much as 150 feet in diameter and 100 feet high.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is poorly suited to the production of Douglas-fir. On the Witzel soil, the site index for Douglas-fir ranges from 110 to 120. On the basis of a site index of 115, the potential production per acre of merchantable timber is 6,360 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 57,960 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are steepness of slope, the areas of Rock outcrop, the shallow soil depth, and the content of rock fragments in the soil. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used for harvesting timber. Use of these methods is limited during December through March, when the soils are saturated. The areas of Rock outcrop make felling and yarding difficult. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Trees are subject to windthrow because of the restricted rooting depth. Droughtiness caused by coarse fragments in the soil reduces seedling survival.

This map unit is in capability subclass VIIs.

91A—Woodburn silt loam, 0 to 3 percent slopes. This deep, moderately well drained soil is on broad valley terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly native grasses, western hazel, poison-oak, Douglas-fir, and Oregon white oak. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown and dark brown silt loam about 16 inches thick. The upper 22 inches of the subsoil is dark yellowish brown and dark brown silty clay loam, and the lower 16 inches is dark brown silt loam. The substratum to a depth of 60 inches or more is dark brown silt loam that is slightly brittle.

Included in this unit are small areas of Aloha, Amity, Huberly, Dayton, and Willamette soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Woodburn soil is moderate to a depth of 38 inches and slow below this depth. Available water capacity is about 10 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly sweet corn, beans, strawberries, and small grain. Among the other crops grown are alfalfa, nursery stock, filberts, and pasture. Some areas are used as homesites and wildlife habitat and for recreation and timber production. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 80 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Woodburn soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by wetness. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 175. On the basis of a site index of 169, the potential production per acre of merchantable timber is 10,800 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 102,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is wetness. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and blackberry limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are slow permeability, wetness, and low soil strength. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Septic tank absorption fields do not function properly during rainy periods because of wetness and the slow permeability.

In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIw.

91B—Woodburn silt loam, 3 to 8 percent slopes. This deep, moderately well drained soil is on broad valley terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly native grasses, western hazel, poison-oak, Douglas-fir, and Oregon white oak. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown and dark brown silt loam about 16 inches thick. The upper 22 inches of the subsoil is dark yellowish brown and dark brown silty clay loam, and the lower 16 inches is dark brown silt loam. The substratum to a depth of 60 inches or more is dark brown silt loam that is slightly brittle.

Included in this unit are small areas of Aloha, Amity, Huberly, Dayton, and Willamette soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Woodburn soil is moderate to a depth of 38 inches and slow below this depth. Available water capacity is about 10 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is droughty in summer.

Most areas of this unit are used for crops, mainly sweet corn, beans, strawberries, and small grain. Among the other crops grown are alfalfa, nursery stock, filberts, and pasture. Some areas are used as homesites and wildlife habitat and for recreation and timber production. This unit is subject to increased use as homesites. Where the unit has been used for homesite development, as much as 80 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 20 inches of fill material or have had as much as 30 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Woodburn soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by wetness. Wetness generally limits the suitability of this unit for deep-rooted crops. Tile drainage can be used to reduce wetness if a suitable outlet is available. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. Diversions and grassed waterways may be needed.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is well suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 175. On the basis of a site index of 169, the potential production per acre of merchantable timber is 10,800 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 102,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is wetness. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and blackberry limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the slow permeability, wetness, and low soil strength. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Septic tank absorption fields do not function properly during rainy periods because of wetness and the slow permeability.

In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIe.

91C—Woodburn silt loam, 8 to 15 percent slopes. This deep, moderately well drained soil is on broad valley terraces. It formed in stratified glaciolacustrine deposits. The vegetation in areas not cultivated is mainly native grasses, western hazel, poison-oak, Douglas-fir, and Oregon white oak. Elevation is 150 to 400 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

Typically, the surface layer is very dark brown and dark brown silt loam about 16 inches thick. The upper 22 inches of the subsoil is dark yellowish brown and dark brown silty clay loam, and the lower 16 inches is dark brown silt loam. The substratum to a depth of 60 inches or more is dark brown silt loam that is slightly brittle.

Included in this unit are small areas of Aloha, Willamette, and Dayton soils. Included areas make up about 10 percent of the total acreage.

Permeability of this Woodburn soil is moderate to a depth of 38 inches and slow below this depth. Available

water capacity is about 10 to 13 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The water table is at a depth of 24 to 36 inches in winter and early in spring. This soil is droughty in summer.

This unit is used mainly for crops such as small grain, hay, and pasture. Berries are also grown. Some areas of the unit are used for timber production and as wildlife habitat and homesites. This unit is subject to increased use as homesites. Where the unit has been used as homesites, as much as 75 percent of the area not covered by buildings or other impervious material has been disturbed. The disturbed areas have been covered by as much as 24 inches of fill material or have had as much as 36 inches of the original profile removed by cutting or grading. The fill material is most commonly from adjacent areas of Woodburn soils that have been cut or graded.

This unit is suited to cultivated crops. It is limited mainly by wetness and slope. Wetness generally limits the suitability of this unit for deep-rooted crops. Crops that require good drainage can be grown if a properly designed tile drainage system is installed. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water.

Excessive cultivation can result in the formation of a tillage pan, which can be broken by subsoiling when the soil is dry. When the soil is wet, grazing and other activities that cause trampling result in compaction of the surface layer, poor tilth, and excessive runoff. If the soil in this unit is plowed in fall, runoff and erosion can be reduced by fertilizing and seeding to a cover crop. All tillage should be on the contour or across the slope. Diversions and grassed waterways may be needed.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 160 to 175. On the basis of a site index of 169, the potential production per acre of merchantable timber is 10,800 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 102,080 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is wetness. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as western hazel and blackberry limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the slow permeability, wetness, low soil strength, and slope. Drainage is needed if roads and buildings are constructed. Wetness is reduced by installing drain tile around footings. Roads and buildings should be designed to offset the limited ability of the soil in this unit to support a load. Preserving the existing plant cover during construction helps to control erosion. Septic tank absorption fields do not function properly during rainy periods because of wetness and the slow permeability.

In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Plants that tolerate wetness and droughtiness should be selected unless drainage and irrigation are provided.

This map unit is in capability subclass IIIe.

92F—Xerochrepts and Haploxerolls, very steep. This map unit is on terrace escarpments. Slope is 20 to 60 percent. The native vegetation is mainly Douglas-fir, Oregon white oak, bigleaf maple, western redcedar, red alder, western hazel, Oregon-grape, and salal. Elevation is 50 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit is about 50 percent Xerochrepts and 35 percent Haploxerolls. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Saum, Jory, Cascade, Witzel, and Woodburn soils. Included areas make up about 20 percent of the total acreage.

Xerochrepts are deep and well drained. They formed in colluvium derived dominantly from igneous rock. No single profile of Xerochrepts is typical, but one commonly observed in the survey area has a surface layer of dark brown silt loam about 8 inches thick. The upper 7 inches of the subsoil is dark brown gravelly loam, and the lower 33 inches is brown and dark yellowish brown gravelly clay loam. The substratum to a depth of 60 inches or more is brown very cobbly clay loam.

Permeability of the Xerochrepts is moderate to moderately slow. Available water capacity is about 5 to 10 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

Haploxerolls are deep and well drained. They formed in colluvium derived dominantly from basic igneous rock. No single profile of Haploxerolls is typical, but one commonly observed in the area has a surface layer of very dark grayish brown silt loam about 12 inches thick. The upper 12 inches of the subsoil is dark brown silt loam, and the lower 26 inches is dark yellowish brown

silty clay loam and gravelly silty clay loam. The substratum to a depth of 60 inches or more is dark yellowish brown very gravelly loam.

Permeability of the Haploxerolls is moderate to moderately slow. Available water capacity is about 8 to 12 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production and as wildlife habitat and homesites.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 130 to 155. On the basis of a site index of 140, the potential production per acre of merchantable timber is 8,700 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 77,280 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is steepness of slope. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other cable logging methods can be used for harvesting timber. Use of these methods is limited during December through March.

The soils in this unit are subject to slumping, especially if road cuts are made in the steeper areas. Slumping can be minimized by locating roads in the more gently sloping areas and by using properly designed road drainage systems. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as red alder and western hazel limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are steepness of slope and the instability of the soils. The soils are subject to slumping, especially if road cuts are made in the steeper areas. Slumping can be minimized by locating roads in the more gently sloping areas and by using properly designed road drainage systems. Erosion is a hazard in the steeper areas. Only the part of the site that is used for construction should be disturbed. This unit generally is too steep to install septic tank absorption fields. Absorption lines should be placed in adjoining areas that are more nearly level.

This map unit is in capability subclass VIIe.

93E—Xerochrepts-Rock outcrop complex, moderately steep. This map unit is on high terraces and rolling uplands. Slope is 0 to 30 percent. The native vegetation is mainly Douglas-fir, Oregon white oak, western hazel, Oregon-grape, poison-oak, and grasses. Elevation is 100 to 500 feet. The average annual precipitation is 40 to 50 inches, the average annual air temperature is 52 to 54 degrees F, and the average frost-free period is 165 to 210 days.

This unit is about 60 percent Xerochrepts and 30 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Witzel, Nekia, and Saum soils. Included areas make up about 10 percent of the total acreage.

Xerochrepts are shallow to moderately deep and are well drained. They formed in colluvium derived dominantly from andesite and basalt. No single profile is typical of Xerochrepts, but one commonly observed in the survey area has a surface layer of dark brown gravelly loam or loam about 8 inches thick. The subsoil is brown gravelly loam or loam about 18 inches thick. Basalt is at a depth of 26 inches. Depth to basalt ranges from 15 to 40 inches.

Permeability of the Xerochrepts is moderate to moderately slow. Available water capacity is about 3 to 7 inches. Effective rooting depth is restricted by the depth to basalt. Runoff is medium, and the hazard of water erosion is moderate. This soil is droughty in summer.

Rock outcrop consists of areas of exposed bedrock. These areas support only moss and lichens.

This unit is used as wildlife habitat and homesites and for timber production.

This unit is poorly suited to the production of Douglas-fir. On the Xerochrepts, the site index for Douglas-fir ranges from 110 to 125. On the basis of a site index of 115, the potential production per acre of merchantable timber is 6,360 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 57,960 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 90 years old.

The main concerns in producing and harvesting timber are the restricted rooting depth and large areas of Rock outcrop, which can interfere with felling, yarding, and other operations involving the use of equipment. The low available water capacity generally influences seedling survival in areas where understory plants are numerous. Brushy plants such as western hazel and Oregon-grape limit natural regeneration of Douglas-fir.

If this unit is used for homesite development, the main limitations are the areas of Rock outcrop and depth to rock. topsoil can be stockpiled and used to reclaim areas disturbed during construction. Removal of gravel in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. The limited depth to bedrock interferes with excavation for utilities and septic tank absorption fields.

This map unit is in capability subclass VIIs.

94D—Zygore gravelly loam, 5 to 30 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in colluvium derived dominantly from basalt and andesite mixed with volcanic ash. The native

vegetation is mainly western hemlock, Douglas-fir, western redcedar, vine maple, salal, and swordfern. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 70 to 100 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 100 days.

Typically, the surface layer is very dark grayish brown gravelly loam about 11 inches thick. The subsoil is dark brown very cobbly loam about 29 inches thick. The substratum to a depth of 60 inches or more is yellowish brown and dark yellowish brown very cobbly loam.

Included in this unit are small areas of Wilhoit and Fernwood soils and Rock outcrop. Included areas make up about 20 percent of the total acreage.

Permeability of this Zygore soil is moderate. Available water capacity is about 5 to 7 inches. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 130 to 165. On the basis of a site index of 140, the potential production per acre of merchantable timber is 8,700 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 77,280 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concern in producing and harvesting timber is the content of coarse fragments. Conventional methods of harvesting timber generally are suitable, but the soil may become compacted if heavy equipment is used when the soil is wet. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as salal and rhododendron limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIs.

94E—Zygore gravelly loam, 30 to 60 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in colluvium derived dominantly from basalt and andesite mixed with volcanic ash. The native vegetation is mainly western hemlock, Douglas-fir, western redcedar, vine maple, salal, and swordfern. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 70 to 100 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 100 days.

Typically, the surface layer is very dark grayish brown gravelly loam about 11 inches thick. The subsoil is dark brown very cobbly loam about 29 inches thick. The substratum to a depth of 60 inches or more is yellowish brown and dark yellowish brown very cobbly loam.

Included in this unit are small areas of Rock outcrop and Wilhoit and Fernwood soils. Included areas make up about 20 percent of the total acreage.

Permeability of this Zygore soil is moderate. Available water capacity is about 5 to 7 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir (fig. 18). The site index for Douglas-fir ranges from 130 to 165. On the basis of a site index of 140, the potential production per acre of merchantable timber is 8,700 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 77,280 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are steepness of slope and the content of coarse fragments. Conventional methods of harvest are difficult to use because of the steepness of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during December through March. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as salal and vine maple limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIs.

94F—Zygore gravelly loam, 60 to 90 percent slopes. This deep, well drained soil is on mountainous uplands. It formed in colluvium derived dominantly from basalt and andesite mixed with volcanic ash. The native vegetation is mainly western hemlock, Douglas-fir, western redcedar, vine maple, salal, and swordfern. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 70 to 100 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 100 days.

Typically, the surface layer is very dark grayish brown gravelly loam about 11 inches thick. The subsoil is dark brown very cobbly loam about 29 inches thick. The substratum to a depth of 60 inches or more is yellowish brown and dark yellowish brown very cobbly loam.

Included in this unit are small areas of Rock outcrop and Fernwood and Wilhoit soils. Included areas make up about 25 percent of the total acreage.

Permeability of this Zygore soil is moderate. Available water capacity is about 5 to 7 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. The site index for Douglas-fir ranges from 130 to 165. On the basis of a site index of 140, the potential production per acre of merchantable timber is 8,700 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 77,280 board feet (International rule, one-eighth-inch

Figure 18.—Clear-cut site preparation for reforestation of Zygore gravelly loam, 30 to 60 percent slopes.

kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are steepness of slope and the content of coarse fragments. Conventional methods of harvest are difficult to use because of the steepness of slope. Highlead or other cable logging methods can be used. Use of these methods is limited during December through March. Roads for year-round use need heavy base rock. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Brushy plants such as salal and vine maple limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIIs.

95E—Zygore-Wilhoit gravelly loams, 30 to 60 percent slopes. This map unit is on mountainous uplands. The native vegetation is mainly Douglas-fir, western hemlock, red alder, vine maple, Oregon-grape, salal, and swordfern. Elevation is 1,800 to 3,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free period is 45 to 100 days.

This unit is 45 percent Zygore gravelly loam and 40 percent Wilhoit gravelly loam. The components of this

unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Fernwood and Memaloose soils. Included areas make up about 15 percent of the total acreage.

The Zygore soil is deep and well drained. It formed in colluvium derived dominantly from andesite and basalt mixed with volcanic ash. Typically, the surface layer is very dark grayish brown gravelly loam about 11 inches thick. The subsoil is dark brown very cobbly loam about 29 inches thick. The substratum to a depth of 60 inches or more is yellowish brown and dark yellowish brown very cobbly loam.

Permeability of the Zygore soil is moderate. Available water capacity is about 5 to 7 inches. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

The Wilhoit soil is deep and well drained. It formed in colluvium derived dominantly from andesite, tuff, and breccia mixed with volcanic ash. Typically, the upper 4 inches of the surface layer is very dark grayish brown gravelly loam, and the lower 11 inches is very dark grayish brown loam. The upper 28 inches of the subsoil is dark brown loam and clay loam, and the lower 9 inches is dark brown gravelly loam. Soft, weathered tuff is at a depth of 52 inches. Depth to bedrock is 40 to 60 inches of more.

Permeability of the Wilhoit soil is moderate. Available water capacity is about 7 to 13 inches. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used for timber production, wildlife habitat, and recreation.

This unit is suited to the production of Douglas-fir. On the Zygore soil, the site index for Douglas-fir ranges from 130 to 165. On the basis of a site index of 140, the potential production per acre of merchantable timber is 8,700 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 77,280 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

On the Wilhoit soil, the site index for Douglas-fir ranges from 130 to 170. On the basis of a site index of 150, the potential production per acre of merchantable timber is 9,480 cubic feet from an even-aged, fully stocked stand of trees 60 years old or 86,800 board feet (International rule, one-eighth-inch kerf) from an even-aged, fully stocked stand of trees 80 years old.

The main concerns in producing and harvesting timber are steepness of slope and the hazard of erosion. The steepness of slope limits the kinds of equipment that can be used in forest management. Highlead or other logging systems that fully or partially suspend logs reduce disturbance of the soil. Severe erosion or gullying can occur where the soil is disturbed. Landsliding and slumping can result where roads are constructed on this unit. Roads and landings can be protected from erosion by constructing water bars and by seeding cuts and fills. Roads for year-round use need heavy base rock. Brushy plants such as vine maple and red alder limit natural regeneration of Douglas-fir.

This map unit is in capability subclass VIIs.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The supply of high quality farmland is limited, and the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, must encourage and facilitate the use of our nation's prime farmland with wisdom and foresight.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. Soil quality, length of growing season, and moisture supply are adequate to economically produce a sustained high yield of crops when managed properly. Prime farmland produces the highest yields with minimal energy and economic resources and causes the least disturbance of the environment.

Prime farmland may now be in cultivated cropland, rangeland, woodland, or other uses. It does not include urban and built-up areas or water areas. To qualify as prime farmland, it must be used for producing food or fiber or be available for these uses. For more detailed information on the criteria for prime farmland, consult the local office of the Soil Conservation Service.

The prime farmland in this survey area has an adequate and dependable supply of moisture from precipitation or irrigation. Temperature and length of growing season are favorable, and levels of acidity or alkalinity are acceptable. There are few if any rocks, and the soils are permeable to water and air. Prime farmland is not excessively erodible, is not saturated with water for long periods, and is not frequently flooded. The slope ranges mainly from 0 to 8 percent.

Nearly 30 percent of the area, or about 186,750 acres, meets the soil requirements for prime farmland. About 3 percent of the soils in the area, or about 23,500 acres, would qualify as prime farmland but is in urban uses (fig. 19). The urban development has taken place primarily in the northwestern part of the survey area.

The areas of prime farmland are predominantly in the western half of the survey area, and they are mainly in general soil map units 4, 5, 6, 10, and 11. Other units that have prime farmland are units 1, 2, 3, 7, 9, 12, and 13. The crops grown on the prime farmland are mainly wheat, sweet corn, nursery stock, strawberries, and red

Figure 19.—Urban development in an area of Canderly soils.

raspberries. These crops account for more than half of the total agricultural income of the survey area.

Prime farmland in the survey area continues to be lost to industrial and urban uses, especially the prime farmland in the northwestern part. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and difficult to cultivate and are less productive.

The detailed soil map units that make up the prime farmland in this survey area are listed in this section. This list does not constitute a recommendation for a particular land use but is intended to show which detailed map units in the survey area are best suited to farming. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units."

Soils that have limitations, such as a high water table, susceptibility to flooding, or low rainfall, may qualify as prime farmland if these limitations are overcome by such measures as drainage, flood control, or irrigation. In the following list, measures to overcome any limitations are shown in parentheses after the map unit name. Onsite evaluation is necessary to see if corrective measures have overcome the limitations.

1A Aloha silt loam, 0 to 3 percent slopes (if drained)
1B Aloha silt loam, 3 to 6 percent slopes (if drained)
2B Alspaugh clay loam, 2 to 8 percent slopes
3 Amity silt loam (if drained)
8B Bornstedt silt loam, 0 to 8 percent slopes
12A Canderly sandy loam, 0 to 3 percent slopes (if irrigated)
12B Canderly sandy loam, 3 to 8 percent slopes (if irrigated)
13B Cascade silt loam, 3 to 8 percent slopes (if drained)
15B Cazadero silty clay loam, 0 to 7 percent slopes
16 Chehalis silt loam
17 Clackamas silt loam (if drained)
19 Cloquato silt loam
20 Coburg silty clay loam
23B Cornelius silt loam, 3 to 8 percent slopes
24B Cottrell silty clay loam, 2 to 8 percent slopes
37B Helvetia silt loam, 3 to 8 percent slopes
45B Jory silty clay loam, 2 to 8 percent slopes
48B Kinton silt loam, 3 to 8 percent slopes
53A Latourell loam, 0 to 3 percent slopes
53B Latourell loam, 3 to 8 percent slopes
54B Laurelwood silt loam, 3 to 8 percent slopes
55 Malabon silty clay loam
56 McBee silty clay loam
57A McBee Variant loam (if drained)
61A Multnomah silt loam, 0 to 3 percent slopes
64B Nekia silty clay loam, 2 to 8 percent slopes (if irrigated)
67 Newberg fine sandy loam (if irrigated)
68 Newberg loam (if irrigated)
70B Powell silt loam, 0 to 8 percent slopes (if drained)
71A Quatama loam, 0 to 3 percent slopes
71B Quatama loam, 3 to 8 percent slopes
76B Salem silt loam, 0 to 7 percent slopes
77B Salem gravelly silt loam, 0 to 7 percent slopes
78B Saum silt loam, 3 to 8 percent slopes
79B Sawtell silt loam, 0 to 8 percent slopes
80B Springwater loam, 2 to 8 percent slopes (if irrigated)
83 Wapato silt loam (if drained)
84 Wapato silty clay loam (if drained)
86A Willamette silt loam, 0 to 3 percent slopes
86B Willamette silt loam, 3 to 8 percent slopes
87A Willamette silt loam, gravelly substratum, 0 to 3 percent slopes
88A Willamette silt loam, wet, 0 to 3 percent slopes
88B Willamette silt loam, wet, 3 to 7 percent slopes
91A Woodburn silt loam, 0 to 3 percent slopes
91B Woodburn silt loam, 3 to 8 percent slopes

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 behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding (fig. 20), 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 rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife

Figure 20.—Flooding in an area of Wapato soils.

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

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained (*25*); and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Many different kinds of crops are grown in the survey area (fig. 21). These crops account for about half of the total income derived from agriculture in the survey area. The other half is derived from livestock, dairy, and poultry. Of the estimated gross agricultural income for Clackamas County in 1981, as reported by the Cooperative Extension Service, nursery stock accounts for about 35 percent, vegetables for 15 percent, berries for 8 percent, and grain for 7 percent. Other crops commonly grown in the area include filberts, hay, and grass seed. Some crops that are not commonly grown but that have good potential are grapes, peppermint, cucumbers, and cabbage.

The survey area has a wide range of soil and climatic conditions (*12*) that affect the use and management of the soils for crops and pasture. Soil tests are therefore needed to determine the need for fertilization and soil amendments in specific areas.

The southwestern part of the survey area is the most diversified crop-producing area. Among the crops grown in this area are grain, vegetables, berries, filberts, hay, and pasture. In about two-thirds of this area the main concern for crop production is wetness. Tile drainage systems have been installed in many places, improving the suitability of the soils for most crops. A few soils, such as the Concord, Cove, and Dayton soils, are difficult to drain because of their very slow permeability or lack of suitable outlets, or both.

In the central part of the survey area are soils that are predominantly well drained, red clay on gently rolling

Figure 21.—Row crops in an area of Latourell soils.

uplands. Hay, pasture, strawberries, red raspberries, and grain are the main crops grown. The main limitations for crop production are the acidity and low fertility of the soils. These limitations can be overcome by applying lime and fertilizer.

The northern part of the survey area has deep, somewhat poorly drained, silty soils to well drained, clayey soils on low rolling hills and high terraces. The main crops grown on these soils are red raspberries, strawberries, and nursery stock. The main limitations for crop production on many of the soils are depth to the hardpan and the seasonal high water table. Drainage can be improved by using tile drainage systems and by subsoiling perpendicularly to the tile lines.

The eastern part of the survey area is predominately mountainous. The soils are mainly gravelly loam to very cobbly loam and have a high content of volcanic ash. Timber production is the main use of these soils, although some crops are grown along the lower slopes. The crops grown are grass seed, red raspberries, hay, and pasture. A high content of rock fragments and steepness of slope are the main limitations for crop production.

The hazard of erosion is moderate to severe where the soils are left barren in winter and where slope is more than 8 percent. A winter cover crop reduces erosion. Other practices that reduce erosion are grassed waterways and crop residue left on the surface. Most of the soils in the survey area are susceptible to compaction if grazing is permitted when the soils are wet. Compaction increases runoff and erosion. Restricting grazing during periods of wetness, using proper stocking rates, and rotating pastures help to maintain the soil in good condition and to minimize erosion.

Application of irrigation water can increase the yield of most of the crops grown in the area. Some of the droughty soils, such as Newberg and Canderly soils, require irrigation to produce most crops. Irrigation water is supplied from wells, streams, or farm ponds. Various types of sprinkler irrigation systems are used.

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 can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Yields per Acre

Howard M. Vance, district conservationist, Soil Conservation Service, and Clayton S. Wills, Jack E. Parsons, and J. Gray Thompson, extension agents, Oregon State University, helped prepare this section.

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. 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 grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations 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. These levels are defined in the following paragraphs.

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 limitation is 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.

Woodland Management and Productivity

James F. McClinton, forester, Soil Conservation Service, prepared this section.

This survey area is one of the better timber growing areas in North America. Most of the best areas for timber production are in the foothills of the Cascade Range. The less productive areas generally are at the higher elevations. Favorable climate and fertile soils account for the high productive capacity of the woodland in much of Clackamas County.

About 50 percent of the survey area is forested. All but a small amount of this is considered to be commercial forest land. About 16 percent of this land is administered by the Bureau of Land Management, and about 2 percent is administered by other public agencies. About 37 percent is managed by large timber companies, and 45 percent is managed by small woodland owners.

The paper pulp industry is centered in Oregon City, where abundant supplies of water are available from the Willamette River. The county also has several large sawmills that produce lumber, veneer, poles, piling, and wood chips suitable for pulp. Most of the chips suitable for use in making both high grade and low grade paper products are processed within the survey area, although some are shipped outside the area. Several smaller sawmills and various specialty mills are in the area. The specialty mills mostly work with hardwood, such as red alder, or make shakes and fencing material from western redcedar.

Sawmill capacity in the county exceeds current growth rates; however, growth rates can be increased significantly by applying intensive management practices. Thinning overstocked stands and applying nitrogen fertilizer on soils that will respond favorably can greatly increase timber yields. Public and private land managers have begun applying intensive management practices in recent years.

The forested areas in the survey area are affected by many different diseases and insects, which may present serious problems in individual stands of trees. Damage varies from year to year. Douglas-fir has several natural enemies. The principal insect that attacks Douglas-fir is the Douglas-fir beetle (*Dendroctonus pseudotsugae*). Laminated root rot is the most serious fungus enemy of Douglas-fir. Western hemlock is attacked by several trunk, butt, and root rots as well as by the hemlock looper (*Lambdina fiscellaria*), which presents the most serious threat of damage by insects. The balsam woolly aphid (*Chermes piceae*) is the most serious insect threat to Pacific silver fir and noble fir. Several types of rot also attack these two species.

The principal forest cover type is the Pacific Douglas-fir type, which typically includes small amounts of western hemlock and western redcedar. The other dominant kinds of forest cover are the Douglas-fir-western hemlock type at intermediate elevations and the Pacific silver fir-hemlock type at higher elevations. Noble fir and Douglas-fir commonly are present in this type of forest, and in some areas mountain hemlock is present instead of western hemlock.

Most of the forest land in the survey area does not provide suitable forage for livestock grazing, but it does provide forage for many species of wildlife. Elk and deer commonly use the forage available in recently harvested areas, and they use dense stands of timber for cover. The most common understory plants are listed in the section "General Soil Map Units."

Soils vary in their ability to produce trees. Depth, fertility, texture, and the available water capacity influence tree growth. Elevation, aspect, soils, and climate determine the kinds of trees that can be expected to grow in any area. Available water capacity and the thickness of the root zone are of major

importance. Elevation and aspect are of particular importance in mountainous areas.

Soil surveys are important to forest land managers as they seek ways to increase the productivity of forest land. Some soils respond better to fertilizer than do others, some are more susceptible to landsliding and erosion after roads are built and timber is harvested, and some require special effort when harvesting timber and reforesting. Each map unit in this survey suitable for producing timber presents information concerning forest land productivity and limitations for harvesting timber and names common forest understory plants. Table 6 summarizes the forestry information given in the detailed map unit descriptions. The site index for Douglas-fir for map units 38E, 39F, 40D, 49D, 49E, 49F, 66D, and 66E was taken from *Height Growth and Site Index for Douglas-fir in High Elevation Forests of the Oregon-Washington Cascades* (*10*). The soils are rated for a number of factors to be considered in management. In table 6, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Equipment limitations ratings refer to the limits placed upon the use of equipment, year-round or seasonally, as a result of soil characteristics. A rating of *slight* indicates that use of equipment is not normally restricted in kind or time of year because of soil factors; *moderate* indicates a seasonal limitation (usually less than 4 months) because of soil wetness, a fluctuating water table, susceptibility to compaction, or some other factor, and *severe* indicates a seasonal limitation, a need for special equipment (such as a cable-yarding logging system) (fig. 22), or a hazard in the use of equipment. Steepness of slope, wetness, and susceptibility of the soil to compaction are the main factors that cause equipment limitations. As slope gradient and length increase, it becomes more difficult to use wheeled equipment. Where slopes are even steeper, tracked equipment cannot be operated safely and more sophisticated systems must be used. Soil wetness, especially in combination with fine soil texture, can severely limit the use of equipment, making harvesting practical only during dry periods.

Seedling mortality ratings refer to the probability of mortality of naturally occurring or planted tree seedlings as influenced by kinds of soil or topography. Plant competition is not considered in this rating. The ratings apply to seedlings from good stock that are planted properly during a period of sufficient soil moisture. *Slight* indicates that no problem is expected under usual conditions; *moderate* indicates that some problems of mortality can be expected and that extra precautions are advisable; and *severe* indicates that mortality will be high and extra precautions are essential for successful reforestation. Wetness of the soil, droughtiness of the surface layer (especially on south- and southwest-facing side slopes), or position on ridgetops account for seedling mortality problems. To offset these limitations, larger than usual planting stock, special site preparation, surface drainage, or reinforcement plantings may be needed.

Ratings of *windthrow hazard* consider the soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees normally are not blown down by wind; *moderate* indicates that an occasional tree may blow down during periods of excessive wetness combined with strong winds (fig. 23); and *severe* indicates that many trees may be expected to be blown down during periods of soil wetness and moderate or strong winds.
Restricted rooting depth because of a high water table, underlying bedrock, an impervious layer, and poor anchoring of roots because the surface layer and subsoil are loose make trees more subject to windthrow. *Moderate* and *severe* ratings indicate the need for more care in thinning the edges of timber stands (fig. 24), a plan calling for periodic salvage of windthrown trees, and an adequate road and trail system to allow for salvage operations.

Ratings of *plant competition* refer to the likelihood of invasion of brushy plants when openings are made in the tree canopy. A rating of *slight* indicates that unwanted brushy plants are not likely to delay the establishment of natural regeneration and that planted seedlings have good prospects for development without undue competition; *moderate* indicates that competition can be expected to reduce natural or planted seedlings without intensive site preparation and maintenance; and *severe* indicates that competition can be expected to prevent adequate natural or planted seedlings unless intensive site preparation and maintenance are provided. Favorable climate and productive soils encourage plant competition. Generally, brush invades less as elevation increases. The key to predicting brush competition problems commonly is the quantity and proximity of seed sources of undesirable plants. Moderate and severe ratings indicate the need for careful and thorough postharvest cleanup in preparation for reforestation and the possibility of mechanically or chemically treating brush to retard the growth and allow seedlings to develop.

The *potential productivity* of important trees on a soil is expressed as a *site index*. This index is determined by taking height and age measurements on selected trees within stands of a given species. The procedure and technique for doing this are given in the site index tables used for the survey area (*10, 14, 26, 30*). Each map unit in this soil survey that is commonly used to produce timber has the yield predicted in both cubic feet and board feet. The yield is predicted at the point where mean annual increment culminates. Where the Curtis site index curves were used to determine productivity, timber yields were estimated using the relationship in Figure 7

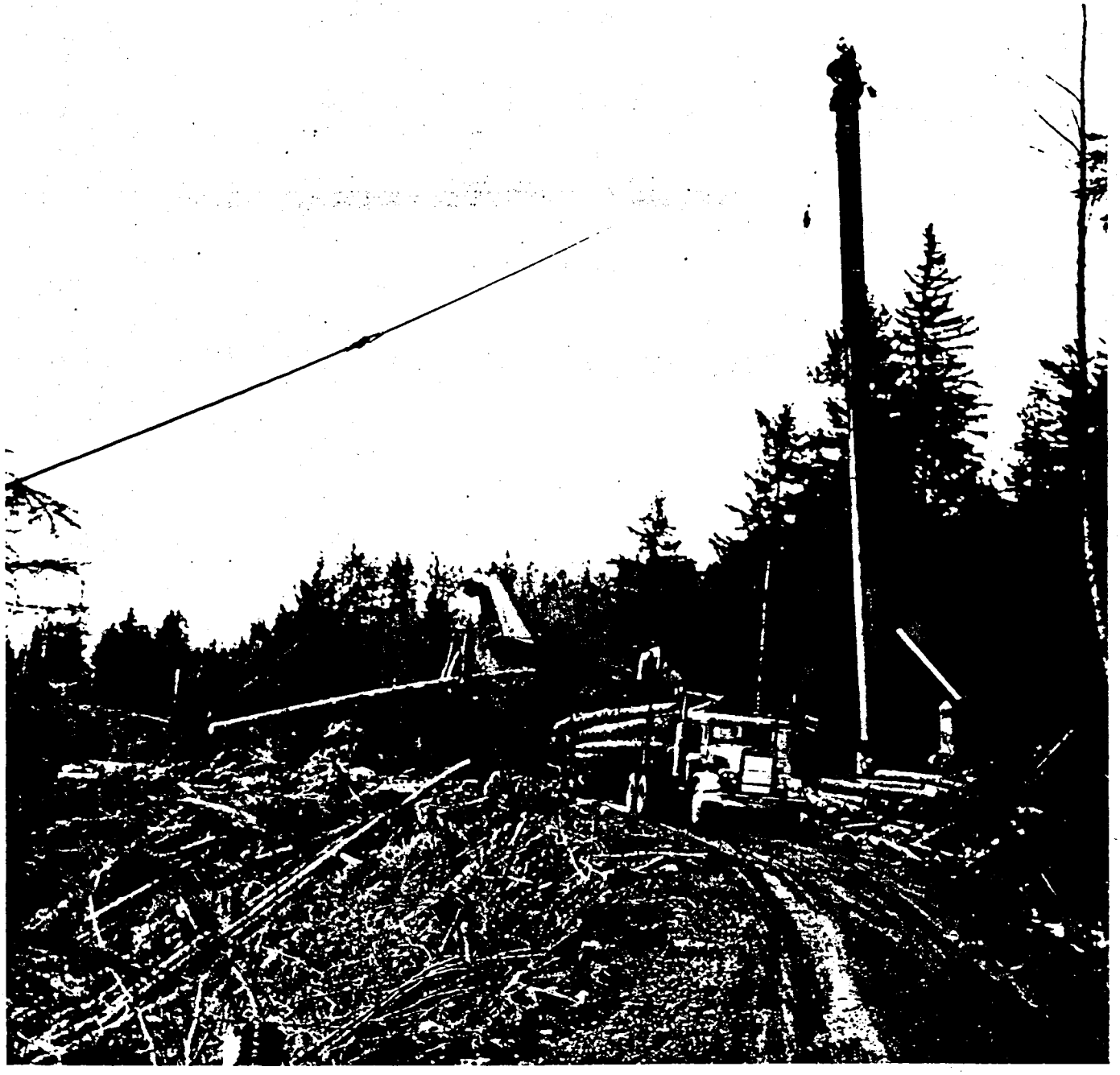


Figure 22.—Cable-yarding systems are used in steeper areas of Zygore soils.

of Curtis et al., 1974. The productivity of the soils in this survey area are usually based on Douglas-fir. On soils where western hemlock or noble fir are listed as trees to plant, however, they may produce greater volumes of wood than Douglas-fir. Important trees are listed in the same order as that of their general occurrence, observed on the soil map unit. Usually, only one or two tree species are dominant.

Trees to plant are those that are used for reforestation or, if suitable conditions exist, natural regeneration.

Species listed are suited to the soils and will produce a commercial wood crop. Desired product, topographic position, and personal preference are three factors of many that can influence the choice of trees to use for reforestation.

Recreation

The soils in the Clackamas County Area are rated in table 7 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 sewerlines. 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 (fig. 25). In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

Figure 23.—Windthrow problems in an area of Talapus soils.

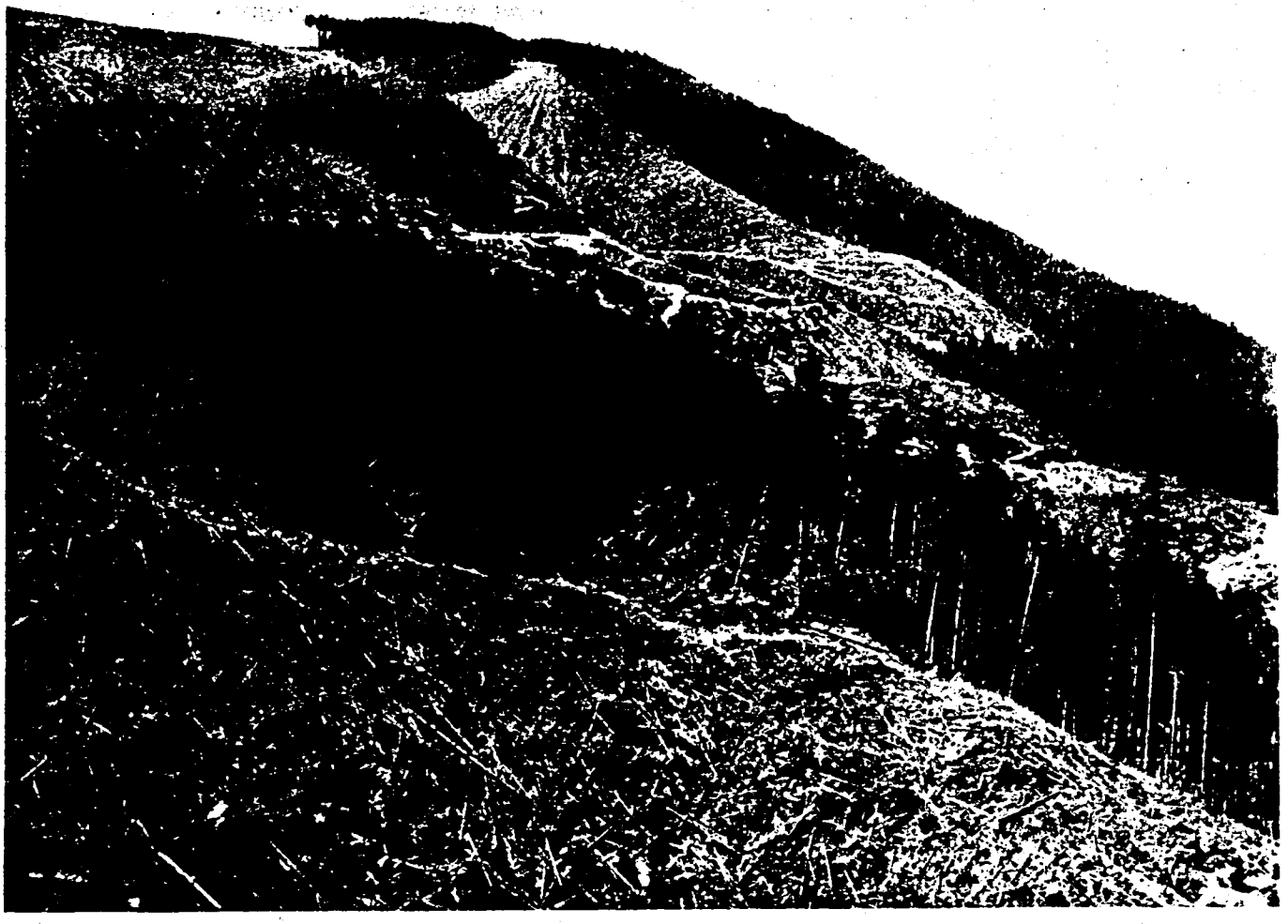


Figure 24.—Windthrow problems associated with large clear-cut areas on Zygore and Wilhoit soils.

In table 7, 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 7 can be supplemented by other information in this survey, for example, interpretations for dwellings without basements and for local roads and streets in table 8 and interpretations for septic tank absorption fields in table 9.

Camp areas require site preparation such as shaping and leveling the tent and parking area (fig. 26), 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, horseback riding, and bicycling 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

Clyde A. Scott, biologist, Soil Conservation Service, prepared this section.

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.

The survey area encompasses varied climatic conditions, topography, land use, and vegetation. Such diverse environmental conditions provide many types of wildlife habitat and therefore an abundance of wildlife species. The conditions in the survey area range from those of the warm low elevations of the river bottoms in the northwestern part to a cold high mountainous area in the southeastern part.

Figure 25.—Flooding in an area of Newberg soils.

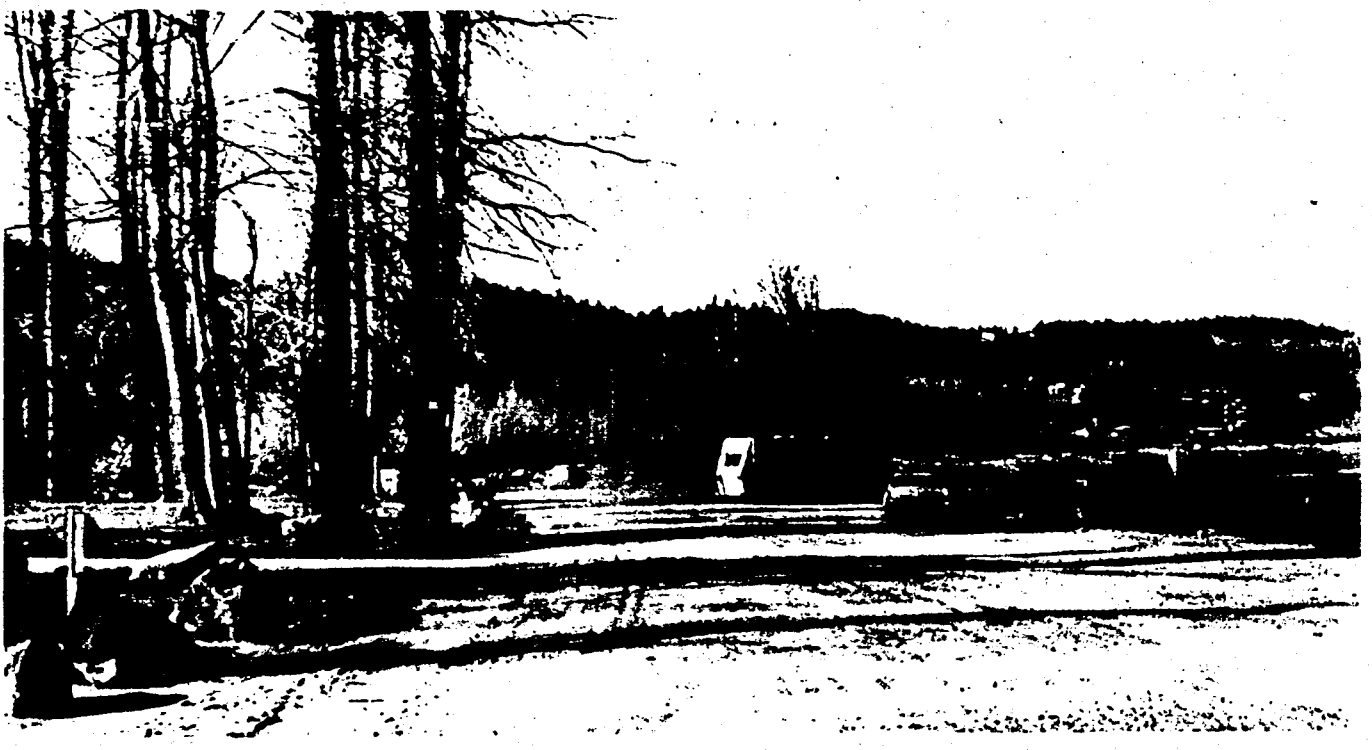


Figure 26.—Clackamette Park recreational development in an area of Newberg soils.

Urbanization, industrial development, and intensive agriculture have influenced wildlife populations in the northern and western parts of the survey area.

Water resources are abundant in ponds, lakes, reservoirs, and rivers, and they provide high quality habitat for many species of fish. Species of anadromous fish using the rivers and streams in the survey area include Chinook salmon, coho salmon, steelhead trout, cutthroat trout, and shad.

The general soil map units shown on the general soil map at the back of this survey have been grouped into four physiographic settings according to their potential to provide similar kinds of wildlife habitat. These four settings along with the kinds of fish and wildlife that inhabit each area are briefly described in the following paragraphs.

Map units 1 and 2.—These units are along the flood plains of the lower reaches of the Willamette, Molalla, and Clackamas Rivers and their tributaries. Wildlife habitat in these units is provided by riparian vegetation and cultivated crops. There is a heavy encroachment of urban and suburban development upon wildlife populations. The vegetation in the areas not cultivated is mainly Douglas-fir, cottonwood, bigleaf maple, Oregon white oak, ash, willow, blackberry, and sedge. Cultivated areas are used for hay, pasture, and vegetable crops.

These units are inhabited mainly by upland wildlife including ring-necked pheasant, California quail, doves, raccoons, skunks, rabbits, squirrels, and minks. Nongame birds are hawks, owls, crows, ravens, jays, woodpeckers, flycatchers, herons, meadowlarks, robins, and numerous other songbirds that are seasonally abundant. Waterfowl are seasonally in areas of rivers and adjoining wetlands. Anadromous fish, as well as rainbow trout and some warm-water species, are in the rivers and streams.

Map units 3, 4, 5, 6, 7, and 8.—These units are on the level to moderately steep terraces. Most of the soils in these units are used for cultivated crops. Areas of native vegetation intermingled with areas of cropland include Douglas-fir, Oregon white oak, western redcedar, bigleaf maple, western hazel, blackberry, rose, sedge, and grasses. Cultivated crops include corn, beans, winter wheat, berries, alfalfa, filberts, and nursery stock.

Ponds constructed on these units can be stocked with rainbow trout and warm-water species of fish.

Upland wildlife populations on these units are abundant where not adversely influenced by suburban development. The species on these units include ring-necked pheasant, California quail, doves, rabbits, squirrels, skunks, songbirds, hawks, and owls.

Map units 10, 11, 12, and 13.—These map units are on rolling uplands. The vegetation in areas not cultivated is mainly Douglas-fir, western redcedar, red alder, bigleaf maple, western hazel, Oregon-grape, and trailing blackberry. The cultivated crops include berries, filberts, small grain, potatoes, hay, pasture, and nursery stock. These units also are used for some timber production and as homesites.

These units provide important habitat for wildlife because of the varied plant communities and the range in elevation that characterize the unit. Among the larger animals in the forested areas are black-tailed deer, black bear, and some Roosevelt elk. Among the smaller animals are raccoons, coyotes, rabbits, squirrels, skunks, and numerous species of rodent.

Among the kinds of upland wildlife on these units are blue and ruffed grouse, some ring-necked pheasant, California quail, mountain quail, band-tailed pigeon, dove, hawks, owls, ravens, jays, woodpeckers, and various songbirds.

The streams on these units support a fair population of rainbow trout. Construction of ponds is limited in some areas of the unit but is suitable in others.

Map units 14, 15, 16, 17, and 18.—These units are on mountainous uplands. They are characterized by highly productive woodland and associated bottom lands that provide important habitat for black-tailed deer and Roosevelt elk. Changes in the wildlife habitat as a result of logging and fire in the more heavily wooded areas of these units tend to be rapid.

The native vegetation on these units is mainly Douglas-fir, western hemlock, western redcedar, red alder, vine maple, Oregon-grape, salal, red huckleberry, and swordfern. Noble fir, Pacific silver fir, rhododendron, big huckleberry, and beargrass also grow at the higher elevations. Some areas of the bottom lands are used for pasture. A limited number of areas are used as homesites. Other important mammals on these units are raccoons, bobcats, coyotes, beavers, minks, weasels, otters, skunks, martens, squirrels, black bears, and numerous species of rodent.

Among the important birds in these units are hawks, owls, jays, crows, ravens, band-tailed pigeon, blue grouse, ruffed grouse, vultures, woodpeckers, and numerous species of small bird.

Nearly all streams in these units provide important habitat for anadromous fish and resident trout.

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 regulation need to 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 to 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 (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2)make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) 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 8 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 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. 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 the 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 to 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 are generally 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 (fig. 27), and slope affect the ease of excavating and grading. Soil strength (fig. 28) (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, the content of salts, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 9 shows the degree and the kind of soil limitations that affect 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 9 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

Figure 27.—Large stones and boulders excavated during street construction on Jory stony silt loam.

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 9 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 because of rapid permeability of 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

Figure 28.—Road deterioration on Humaquepts, ponded.

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 needs to be considered.

The ratings in table 9 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 wind erosion.

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 10 gives information about the soils as a source of roadfill, sand, gravel, and topsoil (*4, 5*). 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 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, 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 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 the depth to the water table is less than 1 foot. They 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. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 10, 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 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 11 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 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.

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 reduce 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 wind 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 wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, 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 (*27*). 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 classifications, 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 12 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 (*24*). 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 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 (*5*) and the system adopted by the American Association of State Highway and Transportation Officials (*4*).

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, SP-SM.

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 3 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 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 13 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.

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 earth-moving 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 1/3 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, very fine sand, sand, and organic matter (as much as 4 percent) and on soil structure and permeability. The estimates are modified by the presence of rock fragments. Values of K range from 0.02 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 13, 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

Table 14 gives 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 intake 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 14 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, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal 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, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

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 14 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 the table.

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 specified as 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.

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.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*29*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 15 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Inseptisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquept (*Aqu*, meaning water or wet, and *ept*, from Inseptisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aqu*, for wetness or water, and *oll*, from Mollisols).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Xerumbrepts.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, mixed, mesic Typic Xerumbrepts.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*24*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*29*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Aloha Series

The Aloha series consists of deep, somewhat poorly drained soils that formed in stratified glaciolacustrine deposits. These soils are on broad valley terraces. Slopes are 0 to 6 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is 53 degrees F.

Typical pedon of Aloha silt loam, 0 to 3 percent slopes, in a field about 3 miles southwest of Canby, in the NW1/4SW1/4SW1/4 of sec. 17, T. 4 S., R. 1 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, friable, nonsticky

and slightly plastic; many fine and very fine roots; many fine irregular pores; medium acid; abrupt smooth boundary.

B1—8 to 22 inches; dark brown and yellowish brown (10YR 4/3, 5/4) heavy silt loam, light yellowish brown (10YR 6/4) dry; many fine distinct dark reddish brown (5YR 3/4) and dark brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine roots; many fine and medium tubular pores; medium acid; clear wavy boundary.

B2—22 to 35 inches; dark grayish brown and dark brown (10YR 4/2, 4/3) heavy silt loam, pale brown (10YR 6/3) dry; many fine distinct dark grayish brown (10YR 4/2), brown (7.5YR 5/4), and reddish brown (5YR 4/4) mottles; weak coarse subangular blocky structure; hard, firm, sticky and slightly plastic; slightly brittle; common fine roots; many fine and medium tubular pores; thin patchy clay films on pores; medium acid; gradual wavy boundary.

B3—35 to 51 inches; dark grayish brown and dark brown (10YR 4/2, 4/3) loam, pale brown (10YR 6/3) dry; many fine distinct dark grayish brown (10YR 4/2), brown (7.5YR 5/4), and reddish brown (5YR 4/4) mottles; weak coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; slightly brittle; few fine roots; many fine and medium tubular pores; thin patchy clay films; slightly acid; gradual wavy boundary.

C1—51 to 60 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; common dark grayish brown (10YR 4/2) streaks along root channels; massive; hard, firm, slightly sticky and slightly plastic; many fine tubular pores; medium acid; gradual irregular boundary.

C2—60 to 80 inches; dark grayish brown (10YR 4/2), stratified very fine sandy loam and silt loam; massive; slightly acid.

The mean annual soil temperature is 54 to 56 degrees F. Depth to bedrock is more than 5 feet.

The A horizon has value of 5 or 6 when dry, and it has chroma of 2 or 3 when moist or dry.

The B horizon has value of 4 or 5 when moist, and it has chroma of 3 or 4 to a depth of 20 inches and 2 to 4 below this depth. The horizon has mottles that are faint to distinct throughout. The mottles have chroma of 2 or less to a depth of 30 inches. The B horizon is silt loam or loam. It has 18 to 27 percent clay and less than 15 percent material that is coarser than very fine sand. The lower part of the B horizon is slightly brittle or very weakly cemented, and it has few to continuous coatings of gray sand and silt grains. Thin clay or organic coatings range from few to continuous.

Individual strata of the C horizon are silt loam, loam, or very fine sandy loam.

Alspaugh Series

The Alspaugh series consists of deep, well drained soils that formed in alluvium and colluvium derived from andesite and tuff. These soils are on high terraces and rolling uplands at the edge of mountainous areas. Slopes are 2 to 90 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Alspaugh clay loam, 2 to 8 percent slopes, in a field about 5.5 miles east of Estacada and 200 feet north of road intersection, in the SW1/4SE1/4NE1/4 of sec. 20, T. 3 S., R. 5 E.

Ap—0 to 7 inches; dark brown (7.5YR 3/2) clay loam, brown (10YR 5/3)dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; many fine and medium concretions; medium acid; abrupt smooth boundary.

A3—7 to 14 inches; dark brown (7.5YR 3/3) clay loam, brown (10YR 5/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; many very fine irregular pores; few fine concretions; medium acid; clear wavy boundary.

B1—14 to 19 inches; dark brown (7.5YR 4/4) clay, brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; many very fine tubular pores; few fine concretions; strongly acid; clear wavy boundary.

B21t—19 to 26 inches; reddish brown (5YR 4/4) clay, reddish brown (5YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; common moderately thick clay films; few fine concretions; strongly acid; gradual wavy boundary.

B22t—26 to 35 inches; reddish brown (5YR 4/4) clay, reddish brown (5YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; many very fine tubular pores; common moderately thick clay films; few fine concretions; strongly acid; gradual wavy boundary.

B3t—35 to 43 inches; reddish brown (5YR 4/4) clay, reddish brown (5YR 5/4) dry; weak fine and medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common very fine tubular pores; few thin clay films; 5 percent fine root fragments; strongly acid; clear wavy boundary.

IIC—43 to 60 inches; reddish brown (5YR 4/4) very gravelly clay, brown (7.5YR 5/4) dry; massive; very hard, very firm, sticky and plastic; few fine irregular pores in fractures; 30 percent weathered gravel and

20 percent weathered cobbles. Rock fragments are andesite and tuff; strongly acid.

The mean annual soil temperature is 47 to 51 degrees F. Depth to bedrock is 60 inches or more.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. The horizon has 0 to 15 percent gravel.

The B2t horizon has hue of 5YR or 7.5YR, and it has value of 3 or 4 when moist and 4 or 5 when dry. It is clay loam, clay, or silty clay loam and averages 35 to 45 percent clay. The horizon has 0 to 20 percent gravel and 0 to 10 percent cobbles. Rock fragments are weathered andesite and tuff.

The B3t horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is clay loam, clay, or silty clay. It has 5 to 20 percent gravel and 0 to 20 percent cobbles, consisting of weathered andesite and tuff.

The IIC horizon has hue of 5YR, 7.5YR, or 10YR, and it has value of 4 or 5 when moist and 5 or 6 when dry. It is very gravelly clay loam or very gravelly clay. The horizon has 30 to 50 percent gravel and 0 to 20 percent cobbles, consisting of weathered andesite and tuff.

Amity Series

The Amity series consists of deep, somewhat poorly drained soils on broad valley terraces. These soils formed in stratified glaciolacustrine deposits. Slopes are 0 to 3 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is 52 degrees F.

Typical pedon of Amity silt loam, about 1/4 mile south of Marquam, in the SW1/4NE1/4NE1/4 of sec. 9, T. 6 S., R. 1 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; medium acid; clear smooth boundary.

A1—8 to 15 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many fine roots; common fine irregular pores and common very fine tubular pores; medium acid; clear smooth boundary.

A2—15 to 22 inches; dark gray (10YR 4/1) silt loam, light gray (5YR 7/1) dry; common fine faint brown (7.5YR 5/4) mottles; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many fine irregular pores; common medium brown and black concretions; medium acid; clear wavy boundary.

B21t—22 to 28 inches; grayish brown (10YR 5/2) silty clay loam, pale brown (10YR 6/3) dry; common fine distinct brown (7.5YR 5/4) mottles; moderate coarse subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; common very fine tubular pores; silt and sand grains on faces of peds; common moderately thick clay films; medium acid; gradual wavy boundary.

B22t—28 to 35 inches; light olive brown (2.5Y 5/4) silty clay loam, very pale brown (10YR 7/4) dry; common fine distinct reddish brown (5YR 5/4) and gray (10YR 5/1) mottles; moderate coarse subangular blocky structure; very hard, firm, sticky and plastic; few fine roots; common very fine tubular pores; common moderately thick clay films; slightly acid; gradual wavy boundary.

C—35 to 62 inches; olive brown (2.5Y 4/4) silty clay loam, very pale brown (10YR 7/4) dry; common fine faint mottles; massive; hard, friable, slightly sticky and slightly plastic; common very fine tubular pores; common thick clay films in pores; slightly acid.

The mean annual soil temperature is 53 to 55 degrees F. Thickness of the solum is 30 to 50 inches. Depth to bedrock is more than 60 inches. A perched water table is at a depth of less than 18 inches in winter.

The A1 horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. The A2 horizon has hue of 10YR or 5Y, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 0 to 2 when moist or dry. It has faint to distinct mottles.

The B horizon has hue of 10YR, 7.5YR, or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2, 3, or 4 when moist or dry.

Aschoff Series

The Aschoff series consists of deep, well drained soils on mountainous uplands. These soils formed in colluvium derived from andesite and basalt mixed with volcanic ash. Slopes are 5 to 90 percent. The mean annual precipitation is about 90 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Aschoff cobbly loam, 30 to 60 percent slopes, 1 mile northwest of Brightwood, in the SE1/4SW1/4SE1/4 of sec. 14, T. 2 S., R. 6 E.

O1—1 inch to 0; organic layer of needles and twigs.

A1—0 to 6 inches; very dark brown (10YR 2/2) cobbly loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine irregular pores; 15 percent gravel and 15 percent cobbles; medium acid; clear smooth boundary.

A3—6 to 17 inches; very dark grayish brown (10YR 3/2) cobbly loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; 15 percent gravel and 15 percent cobbles; medium acid; clear smooth boundary.

B2—17 to 28 inches; dark brown (10YR 4/3) very cobbly loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; 30 percent cobbles and 15 percent gravel; slightly acid; clear smooth boundary.

C—28 to 60 inches; dark yellowish brown (10YR 4/4) very cobbly loam, yellowish brown (10YR 5/4) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; 30 percent cobbles, 20 percent gravel, and 20 percent stones; slightly acid.

The average annual soil temperature is about 51 degrees F. The profile is more than 60 inches deep to bedrock.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when dry or moist. It has 10 to 30 percent gravel and 15 to 30 percent cobbles.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4, 5, or 6 when dry, and chroma of 3 or 4 when moist or dry. It is very gravelly or very cobbly loam. The horizon has 20 to 45 percent cobbles, 15 to 25 percent gravel, and 0 to 10 percent stones.

The C horizon has hue of 10YR or 7.5YR, and it has value of 4 or 5 when moist and 5 or 6 when dry. The horizon has 30 to 50 percent cobbles, 20 to 30 percent gravel, and 0 to 20 percent stones.

Borges Series

The Borges series consists of deep, poorly drained soils that formed in mixed clayey alluvium. These soils are in concave areas on rolling uplands and high terraces. Slopes are 0 to 8 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Borges silty clay loam, 0 to 8 percent slopes, about 1 mile west of West Linn and 100 feet east of Salomo Road, in the NW1/4SW1/4SE1/4 of sec. 26, T. 2 S., R. 1E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine tubular pores; strongly acid; clear smooth boundary.

A1—7 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots; many very fine tubular pores; strongly acid; clear smooth boundary.

B2g—12 to 18 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

IIC1g—18 to 24 inches; dark gray (10YR 4/1) silty clay, grayish brown (10YR 5/2) dry; common medium distinct brown (7.5YR 4/4) mottles; massive; very hard, very firm, very sticky and very plastic; common very fine tubular pores; medium acid; gradual wavy boundary.

IIC2g—24 to 45 inches; dark gray (10YR 4/1) and grayish brown (10YR 5/2) silty clay, grayish brown (2.5Y 5/2) dry; many medium distinct brown (7.5YR 4/4) mottles; massive; very hard, very firm, very sticky and very plastic; common very fine tubular pores; medium acid; clear smooth boundary.

IIC3g—45 to 60 inches; brown (10YR 4/3) and grayish brown (10YR 5/2) clay loam, grayish brown (2.5Y 5/2) dry; many medium distinct brown (7.5YR 4/4) mottles; massive; hard, firm, sticky and plastic; common very fine tubular pores; 15 percent weathered gravel; medium acid.

Unless artificially drained, the soils are saturated with water in winter and spring. The mean annual soil temperature is 51 to 53 degrees F. Depth to the IIC horizon is 15 to 25 inches. Depth to bedrock is more than 60 inches. The umbric epipedon is 10 to 15 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 3 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist or dry.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist or dry. It has distinct or prominent mottles.

The IIC horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 1 or 2 when moist or dry. It is silty clay, clay loam, or clay and has 0 to 35 percent weathered gravel.

Bornstedt Series

The Bornstedt series consists of deep, moderately well drained soils that formed in mixed old alluvium. These soils are on rolling uplands and high terraces. Slopes are 0 to 30 percent. The mean annual precipitation is about

55 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Bornstedt silt loam, 0 to 8 percent slopes, about 1.5 miles east of Damascus, in the NW1/4SE1/4NW1/4 of sec. 10, T. 2 S., R. 3 E.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2)dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine irregular pores;medium acid; abrupt smooth boundary.

B21t—8 to 21 inches; reddish brown (5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; hard, firm, slightly sticky and plastic; few fine roots; many very fine tubular pores; few moderately thick clay films; strongly acid; clear wavy boundary.

B22t—21 to 28 inches; reddish brown (5YR 4/4) silty clay loam, light reddish brown (5YR 6/4) dry; moderate fine and medium subangular blocky structure; hard, firm, slightly sticky and plastic; slightly brittle; many very fine tubular pores; few moderately thick clay films; strongly acid; clear wavy boundary.

B23t—28 to 33 inches; brown (7.5YR 5/2) silty clay loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; hard, firm, slightly sticky and plastic; brittle; many fine tubular pores; common thin clay films and few moderately thick clay films; few fine black stains; strongly acid; abrupt smooth boundary.

IIB31t—33 to 48 inches; reddish brown (5YR 4/4) and reddish gray (5YR 5/2) clay, brown and pinkish gray (7.5YR 5/4, 7/2) dry; massive; vertical and diagonal fractures that have gray silty surfaces; very hard, very firm, sticky and plastic; brittle; many very fine tubular pores; common moderately thick clay films on peds and in pores; continuous brown (7.5YR 5/2) 0.1-millimeter-thick silty coating on upper boundary; many fine black stains; very strongly acid; gradual wavy boundary.

IIB32t—48 to 70 inches; variegated reddish brown (5YR 4/4) and brown (7.5YR 5/4) silty clay, light reddish brown (5YR 6/4), reddish brown (5YR 5/4), and pinkish gray (7.5YR 7/2) dry; massive; vertical and diagonal fractures that have gray silty surfaces; hard, firm, slightly sticky and slightly plastic; brittle; many very fine irregular pores; common moderately thick clay films on peds and in pores; common fine black stains; very strongly acid.

The mean annual soil temperature is 52 to 55 degrees F. Depth to the IIB3 horizon is 30 to 40 inches. Depth to bedrock is more than 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist, and chroma of 2 or 3 when moist or dry.

The B2t horizon has hue of 5YR or 7.5YR, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 2 to 6 when moist or dry.

The IIB3t horizon has hue of 7.5YR, 5YR, or 10YR, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 to 6 when moist or dry. It is silty clay or clay.

Brightwood Series

The Brightwood series consists of moderately deep, well drained soils that formed in colluvium derived from tuff and breccia. These soils are on mountainous uplands. Slopes are 60 to 90 percent. The mean annual precipitation is about 90 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of a Brightwood very gravelly loam in an area of Aschoff-Brightwood complex, 60 to 90 percent slopes, 1 mile south of Brightwood, in the NW1/4SW1/4SW1/4 of sec. 26, T. 2 S., R. 6 E.

A1—0 to 4 inches; dark brown (7.5YR 3/2) very gravelly loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and medium roots; many fine irregular pores; 50 percent gravel; strongly acid; abrupt wavy boundary.

B21—4 to 10 inches; dark brown (7.5YR 3/3) very cobbly loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and medium roots; many fine irregular pores; 20 percent cobbles and 20 percent gravel; strongly acid; clear wavy boundary.

B22—10 to 18 inches; dark brown (7.5YR 3/3) very cobbly loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and medium roots; many fine irregular pores; 30 percent cobbles and 20 percent gravel; medium acid; clear wavy boundary.

C1—18 to 34 inches; brown (7.5YR 4/4) extremely gravelly loam, very pale brown (10YR 7/3) dry; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine and medium roots; many fine irregular pores; 50 percent gravel and 20 percent cobbles; strongly acid; gradual wavy boundary.

R—34 inches; tuffaceous bedrock; massive.

The mean annual soil temperature is 47 to 53 degrees F. The solum is 15 to 30 inches thick. Depth to bedrock is 20 to 40 inches. Content of coarse fragments is 35 to 80 percent.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2

or 3 when moist or dry. It has 0 to 25 percent cobbles and 35 to 65 percent gravel.

The B horizon has hue of 7.5YR or 10YR, value of 2, 3, or 4 when moist and 4, 5, or 6 when dry, and chroma of 3 or 4 when moist or dry. It has 20 to 35 percent cobbles and 20 to 50 percent gravel.

The C horizon is lighter in color than the B horizon. It has 20 to 50 percent gravel and 15 to 30 percent cobbles.

Bull Run Series

The Bull Run series consists of deep, well drained soils that formed in silty material that is high in content of volcanic ash. These soils are on mountainous uplands. Slopes are 3 to 60 percent. The mean annual precipitation is about 85 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Bull Run silt loam, 3 to 8 percent slopes, about 4 miles southeast of Sandy, in the SW1/4SW1/4NE1/4 of sec. 22, T. 2 S., R. 5 E.

O1—1 inch to 0; needles, leaves, and twigs.
A1—0 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; many fine irregular pores; many fine concretions; strongly acid; clear smooth boundary.
B1—13 to 19 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine tubular pores; common fine concretions; medium acid; clear smooth boundary.
B21—19 to 28 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; medium acid; clear smooth boundary.
B22—28 to 43 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; many very fine tubular pores; medium acid; clear smooth boundary.
C—43 to 62 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, slightly sticky and slightly plastic; slightly brittle; few very fine and fine roots; many very fine tubular pores; medium acid.

The mean annual soil temperature is 50 to 54 degrees F. The solum is 30 to 60 inches thick or more. Depth to bedrock is 60 inches or more. The umbric epipedon is 10 to 20 inches thick or more.

The A horizon has value of 2 or 3 when moist and 3 to 5 when dry, and it has chroma of 2 when moist or dry.

The B horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry.

Bull Run Variant

The Bull Run Variant consists of deep, somewhat poorly drained soils that formed in silty material that is high in content of volcanic ash. The soils are in drainageways on the western slopes of the Cascade Range. Slopes are 0 to 12 percent. The mean annual precipitation is about 85 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Bull Run Variant silt loam, 0 to 12 percent slopes, about 4 miles east of Sandy, in the SW1/4NE1/4SE1/4 of sec. 22, T. 2 S., R. 5 E.

A1—0 to 6 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many fine irregular pores; common fine concretions; strongly acid; clear smooth boundary.
A3—6 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; many very fine tubular pores; common fine concretions; strongly acid; clear smooth boundary.
B21—14 to 20 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; common fine faint yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; many very fine tubular pores; medium acid; clear smooth boundary.
B22—20 to 38 inches; yellowish brown (10YR 5/4) silt loam, very pale brown (10YR 7/4) dry; many medium faint yellowish brown (10YR 5/8) and grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine tubular pores; medium acid; gradual smooth boundary.
C1—38 to 48 inches; yellowish brown (10YR 5/4) silt loam, very pale brown (10YR 7/3) dry; many large distinct grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/8) mottles; massive; hard, firm, slightly sticky and slightly plastic; few very fine tubular pores; medium acid; abrupt smooth boundary.
IIC2—48 to 60 inches; grayish brown (10YR 5/2) silty clay loam, light gray (10YR 7/1) dry; common medium distinct yellowish brown (10YR 5/6) mottles;

massive; hard, firm, sticky and plastic; few very fine tubular pores; medium acid.

The soils are saturated with water to a depth of 10 inches much of the time in winter and spring. The mean annual soil temperature is 48 to 50 degrees F. Depth to bedrock is 60 inches or more. The umbric epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It is silt loam or loam and has 0 to 15 percent fine concretions.

The B horizon has hue of 10YR, 7.5YR, or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist or dry. It is silt loam or loam.

The IIC horizon, where present, has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 or less when moist or dry. It is silty clay loam or silty clay.

Camas Series

The Camas series consists of deep, excessively drained soils that formed in mixed alluvium. These soils are on flood plains. Slopes are 0 to 3 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Camas gravelly sandy loam, about 2 miles southeast of Canby, in the NW1/4NE1/4NE1/4 of sec. 10, T. 4 S., R. 1 E.

A1—0 to 10 inches; dark brown (10YR 3/3) gravelly sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many fine, medium, and coarse roots; many fine irregular pores; 25 percent gravel; medium acid; clear smooth boundary.

C1—10 to 17 inches; brown (10YR 4/3) gravelly sandy loam, pale brown (10YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; many fine, medium, and coarse roots; many fine irregular pores; 30 percent gravel; slightly acid; clear smooth boundary.

IIC2—17 to 60 inches; variegated brown (10YR 4/3, 5/3) and dark brown (10YR 3/3), stratified extremely gravelly coarse sand and very gravelly loamy sand; massive; soft, very friable, nonsticky and nonplastic; few fine and medium roots; many fine irregular pores; 50 percent gravel and 20 percent cobbles; slightly acid.

The mean annual soil temperature is 53 to 55 degrees F. Depth to the very gravelly IIC horizon is 12 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It has 15 to 35 percent gravel.

The C1 horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is sandy loam or loamy sand and has 20 to 40 percent gravel.

The IIC2 horizon is coarse sand, sand, or loamy sand. It has 30 to 50 percent gravel and 5 to 20 percent cobbles.

Canderly Series

The Canderly series consists of deep, somewhat excessively drained soils that formed in stratified glaciolacustrine deposits. These soils are on terraces. Slopes are 0 to 8 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Canderly sandy loam, 0 to 3 percent slopes, about 100 feet west and 50 feet south of the intersection of Canby Ferry Road and Territorial Road, in the SE1/4SW1/4SW1/4 of sec. 28, T. 3 S., R. 1 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine interstitial pores; medium acid; abrupt smooth boundary.

A1—7 to 15 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine and fine tubular pores; medium acid; clear smooth boundary.

B21—15 to 30 inches; dark brown (10YR 4/3) sandy loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few medium and coarse roots; many very fine tubular pores; medium acid; gradual smooth boundary.

B22—30 to 46 inches; dark yellowish brown (10YR 3/4) sandy loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; loose, nonsticky and nonplastic; few fine roots; many very fine tubular pores; medium acid; clear wavy boundary.

C—46 to 60 inches; stratified, dark yellowish brown (10YR 3/4) loamy sand and coarse sandy loam; single grain; loose, nonsticky and nonplastic; few very fine roots; many fine irregular pores; medium acid.

The mean annual soil temperature is 54 to 56 degrees F. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It is sandy loam, fine sandy loam, or loam.

The B horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 3 or 4 when moist or dry. It is sandy loam, coarse sandy loam, fine sandy loam, or loam.

The C horizon is stratified sand, loamy sand, or coarse sandy loam. It has 0 to 20 percent gravel.

Cascade Series

The Cascade series consists of deep, somewhat poorly drained soils in convex areas of rolling uplands. These soils formed in silty material. Slopes are 3 to 60 percent. The mean annual precipitation is about 55 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Cascade silt loam, 8 to 15 percent slopes (fig. 29), about 0.5 mile north of Damascus, in the NW1/4NW1/4NW1/4 of sec. 5, T. 2 S., R. 3 E.

Ap1—0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots and common fine roots; common very fine tubular pores; medium acid; clear smooth boundary.

Ap2—3 to 11 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots, common fine roots, and few medium roots; few very fine and fine tubular pores; medium acid; gradual wavy boundary.

B2—11 to 21 inches; dark yellowish brown (10YR 4/4) silt loam, light brown (10YR 6/3) dry; common medium prominent mottles; weak medium prismatic structure and moderate medium subangular blocky; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; few very fine tubular pores; silt coatings on peds; common medium black stains; medium acid; gradual wavy boundary.

B1x—21 to 33 inches; dark yellowish brown (10YR 4/4) silt loam, light brown (10YR 6/3) dry; 10 percent brown (7.5YR 5/2) tongues; many large prominent brown (7.5YR 5/4) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure and moderate coarse subangular blocky; hard, firm, slightly sticky and slightly plastic; brittle; few fine roots; few very fine tubular pores; silt coatings on peds; few thin clay films on peds; common large black stains; strongly acid; clear wavy boundary.

B2x—33 to 40 inches; dark yellowish brown (10YR 4/4) silty clay loam, light brown (10YR 6/3) dry; 20 percent brown (7.5YR 5/2) tongues; many medium prominent brown (7.5YR 5/4) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure and moderate coarse subangular blocky; very hard, very firm, slightly sticky and slightly plastic; brittle; few very fine tubular pores; silt coatings on peds; few moderately thick clay films on peds; many large prominent black stains; strongly acid; gradual wavy boundary.

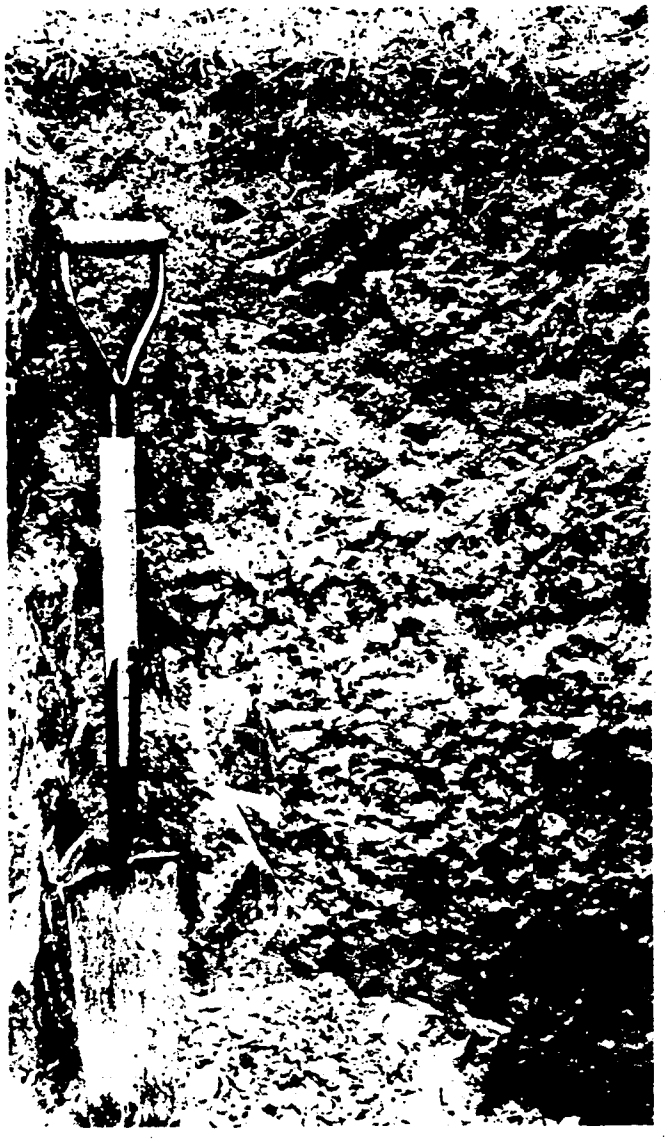


Figure 29.—Profile of Cascade silt loam, 8 to 15 percent slopes.

B3x—40 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; 5 percent brown (7.5YR 5/2) tongues; many medium prominent brown (7.5YR 5/4) and strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; very hard, very firm, slightly sticky and slightly plastic; brittle; few very fine tubular pores; silt coatings on peds; few

moderately thick clay films on peds; many large prominent black stains; strongly acid.

The mean annual soil temperature is 52 to 54 degrees F. Depth to the Bx horizon is 20 to 30 inches. A water table is perched above the Bx horizon in winter. The umbric epipedon is 10 to 19 inches thick.

The A horizon has hue of 7.5YR or 10YR, and it has chroma of 2 or 3 when moist.

The B2 horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is mainly silt loam or light silty clay loam. The horizon has 18 to 30 percent clay and less than 10 percent material that is coarser than very fine sand.

The Bx horizon is 2 feet to more than 4 feet thick. It is silt loam or silty clay loam and is firm or very firm and hard or very hard. It has few or common, thin or moderately thick clay films in the fractures and pores. Few basalt rock fragments are at or near the upper boundary of the Bx horizon. In some areas a buried layer of stony silty clay loam or very stony clay loam is below a depth of 30 inches.

Cazadero Series

The Cazadero series consists of deep, well drained soils that formed in mixed old alluvium. These soils are on high terraces. Slopes are 0 to 30 percent. The mean annual air temperature is about 51 degrees F, and the mean annual precipitation is about 65 inches.

Typical pedon of Cazadero silty clay loam, 0 to 7 percent slopes, 1,200 feet west of the corner of Dunn Road, in the NE1/4SW1/4NW1/4 of sec. 3, T. 2 S., R. 4 E.

Ap1—0 to 6 inches; dark reddish brown (5YR 3/3) silty clay loam, reddish brown (5YR 5/3) dry; moderate fine granular structure; hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine irregular pores; common fine and medium concretions; strongly acid; abrupt smooth boundary.

Ap2—6 to 12 inches; dark reddish brown (5YR 3/3) silty clay loam, reddish brown (5YR 5/3) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; common fine and medium concretions; medium acid; abrupt smooth boundary.

B1—12 to 21 inches; yellowish red (5YR 3/6) silty clay loam, yellowish red (5YR 4/6) dry; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; hard, firm, slightly sticky and plastic; few fine roots; many very fine tubular pores; few fine concretions; medium acid; clear smooth boundary.

B21t—21 to 30 inches; yellowish red (5YR 3/6) silty clay, yellowish red (5YR 4/6) dry; moderate fine and medium subangular blocky structure; very hard, firm, sticky and plastic; many very fine tubular pores; common moderately thick dark red (2.5YR 3/6) clay films on faces of peds and in pores; medium acid; clear smooth boundary.

B22t—30 to 41 inches; yellowish red (5YR 3/6) clay, yellowish red (5YR 4/6) dry; weak medium prismatic structure parting to moderate fine subangular blocky; very hard, firm, sticky and plastic; many very fine tubular pores; common moderately thick dark red (2.5YR 3/6) clay films on faces of peds; strongly acid; gradual smooth boundary.

IIB23t—41 to 50 inches; dark red (2.5YR 3/6) heavy clay, yellowish red (5YR 4/6) dry; moderate fine subangular blocky structure; very hard, firm, sticky and plastic; slightly brittle; many very fine tubular pores; many moderately thick dark red (2.5YR 3/6) clay films on faces of peds; few medium black stains; strongly acid; clear smooth boundary.

IIB31t—50 to 61 inches; dark red (2.5YR 3/6) clay, yellowish red (5YR 4/6) dry; moderate fine subangular blocky structure; very hard, firm, sticky and plastic; brittle; many very fine tubular pores; common moderately thick dark red (2.5YR 3/6) clay films on faces of peds; strongly acid; gradual smooth boundary.

IIB32t—61 to 75 inches; dark reddish brown (5YR 3/4) clay, yellowish red (5YR 4/6) dry; weak coarse subangular blocky structure; very hard, firm, sticky and plastic; brittle; many very fine tubular pores; common fine black stains; few moderately thick dark red (2.5YR 3/6) clay films on faces of peds; strongly acid.

The mean annual soil temperature is 52 to 54 degrees F. Depth to bedrock is more than 60 inches. Thickness of the solum is 60 inches or more.

The A horizon has hue of 7.5YR or 5YR, value of 2 or 3 when moist and 5 when dry, and chroma of 2 or 3 when moist or dry.

The B2t horizon has hue of 2.5YR or 5YR, value of 3 when moist and 4 when dry, and chroma of 4 to 6 when moist or dry. It is silty clay or clay and has 45 to 55 percent clay in the upper 20 inches.

Chehalis Series

The Chehalis series consists of deep, well drained soils on flood plains. These soils formed in mixed alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Chehalis silt loam, 2 miles southeast of Canby, in the SE1/4SW1/4SE1/4 of sec. 3, T. 4 S., R. 1 E.

Ap—0 to 7 inches; dark brown (10YR 3/3) silt loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; slightly acid; abrupt smooth boundary.

A1—7 to 24 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; many fine roots; many very fine tubular pores; slightly acid; gradual smooth boundary.

B2—24 to 44 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

C—44 to 60 inches; dark yellowish brown (10YR 3/4), stratified silty clay loam and fine sandy loam, dark grayish brown (10YR 4/2) dry; massive; hard, firm, sticky and plastic; few fine roots; many very fine tubular pores; slightly acid.

The mean annual soil temperature is 52 to 56 degrees F. Depth to bedrock is more than 60 inches. The mollic epipedon is more than 24 inches thick.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The B horizon has value of 2 or 3 when moist and 4 to 6 when dry, and it has chroma of 2 or 3 when moist or dry.

The C horizon has hue of 10YR or 2.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is silty clay loam or silt loam.

Clackamas Series

The Clackamas series consists of deep, somewhat poorly drained soils on stream terraces. These soils formed in mixed alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical profile of Clackamas silt loam, about 2 miles east of Clackamas, in the SE1/4NW1/4SW1/4 of sec. 11, T. 2 S., R. 2 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, grayish brown (2.5Y 5/2) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; slightly acid; abrupt smooth boundary.

B1—7 to 11 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; common fine distinct mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; many fine roots; many fine tubular pores; strongly acid; clear smooth boundary.

B21t—11 to 20 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; many fine distinct mottles; weak fine subangular blocky structure; hard, firm, sticky and plastic; common fine roots; many fine tubular pores; few thin clay films in pores; few manganese-dioxide coatings; medium acid; clear smooth boundary.

B22t—20 to 36 inches; dark grayish brown (10YR 4/2) gravelly silty clay loam, grayish brown (10YR 5/2) dry; many fine distinct mottles; weak coarse subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; many fine and medium tubular pores; 15 percent gravel; few thin clay films in pores; medium acid; clear smooth boundary.

IICg—36 to 60 inches; variegated dark brown (10YR 3/3) and strong brown (7.5YR 5/6) extremely gravelly silty clay loam, dark grayish brown (2.5Y 4/2), pale brown (10YR 6/3), and light yellowish brown (10YR 6/4) dry; massive; very hard, firm, very sticky and very plastic; 70 percent gravel; medium acid.

The mean annual soil temperature is 52 to 55 degrees F. These soils are saturated with water in winter. Depth to the extremely gravelly IICg horizon is 11 to 36 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist or dry. It is silt loam or gravelly loam and has 0 to 20 percent gravel.

The B horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 1 or 2 when moist or dry. It is silty clay loam, gravelly silty clay loam, or gravelly clay loam and has 0 to 30 percent gravel. In some pedons the lower part of the B horizon has 30 to 50 percent gravel, but the weighted average throughout the horizon is less than 35 percent.

The IICg horizon is highly variegated. It is clay loam or silty clay loam and has 60 to 80 percent gravel.

Cloquato Series

The Cloquato series consists of deep, well drained soils on flood plains. These soils formed in mixed alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Cloquato silt loam, 0.5 mile north of Monitor, in the NW1/4SW1/4NE1/4 of sec. 25, T. 5 S., R. 1 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; medium acid; abrupt smooth boundary.

A1—7 to 15 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 4/3) dry; moderate medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; slightly acid; clear smooth boundary.

B2—15 to 42 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many fine tubular pores; slightly acid; clear smooth boundary.

IIC—42 to 61 inches; dark grayish brown (10YR 4/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few fine roots; many very fine tubular pores; neutral.

The mean annual soil temperature is 52 to 54 degrees F. The solum is 40 to 60 inches thick or more. The mollic epipedon is 20 to 40 inches thick or more.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B2 horizon has chroma of 2 or 3 when moist or dry.

The IIC horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is sandy loam, fine sandy loam, loamy sand, or silt loam. In some pedons the horizon has strata that are sandy loam, silt loam, or loamy sand and are 1 to 2 inches thick.

Coburg Series

The Coburg series consists of deep, moderately well drained soils that formed in mixed silty and clayey alluvium. These soils are on stream terraces. Slopes are 0 to 3 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Coburg silty clay loam, about 100 feet east of the railroad crossing and 20 feet north of Macksburg Road, in the SW1/4SW1/4SW1/4 of sec. 18, T. 4 S., R. 2 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; many fine tubular pores; medium acid; clear smooth boundary.

A1—7 to 20 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

B21t—20 to 24 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR4/2) dry; few medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; many very fine tubular pores; few moderately thick clay films; slightly acid; clear smooth boundary.

B22t—24 to 30 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; common very fine and fine roots; many very fine tubular pores; few moderately thick clay films; slightly acid; clear smooth boundary.

B23t—30 to 36 inches; brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common medium distinct dark yellowish brown (10YR 4/4) and dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; common very fine and fine roots; common very fine tubular pores; few moderately thick clay films; medium acid; clear smooth boundary.

B3t—36 to 60 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; common medium distinct dark yellowish brown (10YR 4/4) and dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; common very fine tubular pores; few moderately thick clay films; medium acid.

The mean annual soil temperature is 52 to 55 degrees F. Thickness of the mollic epipedon is 20 to 30 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It has 0 to 5 percent rock fragments.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist or dry. It is silty clay loam or silty clay and has 0 to 5 percent gravel.

Concord Series

The Concord series consists of deep, poorly drained soils that formed in stratified glaciolacustrine deposits. These soils are on terraces. Slopes are 0 to 2 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Concord silt loam, 1 mile north of Molalla, in the SW1/4SW1/4NE1/4 of sec. 5, T. 5 S., R. 2 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) silt loam, light brownish gray (10YR 6/2) dry; moderate fine subangular blocky structure; slightly hard, friable,

slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; strongly acid; abrupt smooth boundary.

A2—6 to 20 inches; very dark grayish brown (10YR 3/2) silty clay loam, light brownish gray (10YR 6/2) dry; common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; strongly acid; clear smooth boundary.

B1—20 to 28 inches; brown (10YR 5/3) silty clay loam, light gray (2.5Y 7/2) dry; common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; many very fine tubular pores; strongly acid; clear smooth boundary.

IIB2tg—28 to 36 inches; grayish brown (10YR 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; many fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; hard, firm, very sticky and very plastic; few very fine roots; many very fine tubular pores; common moderately thick clay films; medium acid; gradual smooth boundary.

IIC1—36 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, grayish brown (2.5Y 5/2) dry; many medium distinct dark yellowish brown (10YR 4/4) mottles; massive; very hard, very firm, sticky and plastic; few very fine roots; many very fine tubular pores; few fine black concretions; medium acid.

The mean annual soil temperature is 53 to 55 degrees F. These soils are saturated with water in winter. Depth to bedrock is more than 60 inches. Depth to mottles is 0 to 6 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. It is silty loam or silty clay loam.

The Bt horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 to 3 when moist or dry. It is heavy silty clay loam, silty clay, or clay and has 35 to 50 percent clay.

The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist or dry, and chroma of 1 or 2 when moist or dry. It is silty clay loam or silt loam.

Conser Series

The Conser series consists of deep, poorly drained soils that formed in mixed silty and clayey alluvium. These soils are on terraces. Slopes are 0 to 3 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Conser silty clay loam, about 2 miles southwest of Mulino, in the NE1/4NE1/4SW1/4 of sec. 19, T. 4 S., R. 2 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; many fine irregular pores; medium acid; clear smooth boundary.

B1g—7 to 18 inches; very dark gray (10YR 3/1) silty clay loam, grayish brown (10YR 5/2) dry; common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; many very fine and fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

B21tg—18 to 34 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; many very fine tubular pores; common moderately thick clay films in pores; medium acid; clear smooth boundary.

B22tg—34 to 48 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; many fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; very hard, very firm, very sticky and very plastic; common very fine and fine roots; many very fine tubular pores; common moderately thick clay films; medium acid; abrupt smooth boundary.

IIC—48 to 60 inches; brown (10YR 4/3) loam, brown (10YR 5/3) dry; many fine distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; massive; hard, firm, slightly sticky and slightly plastic; common very fine tubular pores; slightly acid.

The mean annual soil temperature is 52 to 56 degrees F. These soils are saturated with water in winter. The mollic epipedon is 24 to 34 inches thick. The solum has 0 to 5 percent gravel.

The A horizon has value of 2 or 3 when moist and 3 to 5 when dry, and it has chroma of 1 or 2 when moist or dry.

The B horizon has value of 3 to 5 when moist and 4 to 6 when dry, and it has chroma of 1 to 3 when moist or dry. It has common or many, fine or medium, distinct mottles. The horizon is silty clay, clay, or heavy silty clay loam.

The IIC horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 2 to 4 when moist or dry. It has many fine to coarse, faint to distinct mottles. The horizon is loam, clay loam, or sandy loam.

Cornelius Series

The Cornelius series consists of deep, moderately well drained soils on rolling uplands. These soils formed in silty material. Slopes are 2 to 60 percent. The mean

annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Cornelius silt loam, 8 to 15 percent slopes, about 0.5 mile south of Oswego Lake, in the SW1/4NW1/4NE1/4 of sec. 15, T. 2 S., R. 1 E.

Ap—0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; medium acid; abrupt smooth boundary.

A1—4 to 9 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; many very fine tubular pores; medium acid; clear smooth boundary.

B1—9 to 16 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; thin grayish brown silt coatings on some peds; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; many very fine tubular pores; medium acid; clear smooth boundary.

B2t—16 to 34 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine and medium roots; many very fine tubular pores; common moderately thick dark brown (7.5YR 4/4) clay films; medium acid; clear smooth boundary.

B1x—34 to 38 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; grayish brown (10YR 5/2) tongues; common distinct strong brown (7.5YR 5/6) mottles; strong medium subangular blocky structure; very firm, slightly sticky and slightly plastic; brittle; many very fine tubular pores; common moderately thick clay films; many black concretions; medium acid; gradual smooth boundary.

B2x—38 to 60 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; common distinct strong brown (7.5YR 5/6) mottles; moderate coarse subangular blocky structure; very firm, slightly sticky and slightly plastic; brittle; common very fine tubular pores; few moderately thick clay films; many black concretions; medium acid.

The mean annual soil temperature is 52 to 56 degrees F. Depth to the Bx horizon is 30 to 40 inches.

The A horizon has value of 2 or 3 when moist and 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The B2t horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry.

The Bx horizon has color similar to that of the B2t horizon, but the Bx horizon has faint to prominent mottles that have chroma of more than 2 and tongues that have chroma of 2. The Bx horizon is silty clay loam or silt loam. It overlies dark reddish brown clay in some areas.

Cottrell Series

The Cottrell series consists of deep, moderately well drained soils on high terraces and rolling uplands. These soils formed in old alluvium. Slopes are 2 to 30 percent. The mean annual precipitation is about 60 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Cottrell silty clay loam, 2 to 8 percent slopes, in an area of pasture about 0.5 mile northwest of Sandy, in the SE1/4NW1/4NE1/4 of sec. 14, T. 2 S., R. 4 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine irregular pores; many fine concretions; medium acid; clear smooth boundary.

A3—6 to 12 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine and fine tubular pores; common fine concretions; strongly acid; clear smooth boundary.

B11—12 to 15 inches; dark brown (7.5YR 3/3) silty clay loam, brown (7.5YR 5/3) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; many very fine tubular pores; strongly acid; clear smooth boundary.

B12—15 to 24 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; common very fine tubular pores; few thin yellowish red (5YR 4/6) clay films; 5 percent fine weathered gravel; strongly acid; clear smooth boundary.

B21t—24 to 42 inches; dark brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) dry; common fine distinct yellowish red (5YR 5/6) and grayish brown (10YR 5/2) mottles; moderate coarse subangular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine roots; common very fine tubular pores; common moderately thick yellowish red (5YR 4/6) clay films; 10 percent fine weathered gravel; strongly acid; clear smooth boundary.

B22t—42 to 55 inches; dark brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) dry; common medium distinct yellowish red (5YR 5/6) and grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; hard, firm, sticky and very plastic; common very fine roots; common very fine tubular

pores; many moderately thick yellowish red (5YR 4/6) clay films; common medium black concretions; strongly acid; clear wavy boundary.

B3t—55 to 86 inches; reddish brown (5YR 4/4) silty clay loam, yellowish red (5YR 5/6) dry; common fine distinct yellowish red (5YR 5/8) and grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine tubular pores; common thin yellowish red (5YR 4/6) clay films; common medium black stains; strongly acid.

The mean annual soil temperature is 52 to 55 degrees F. Unless these soils are artificially drained, they are saturated with water in winter and early in spring. Depth to bedrock is 60 inches or more.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B2t horizon has hue of 7.5YR or 5YR, value of 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is silty clay or clay. The upper 10 inches of the horizon has distinct mottles that have value of 4 or 5 when moist and chroma of 2 when moist.

Cove Series

The Cove series consists of deep, poorly drained soils that formed in clayey alluvium. These soils are on flood plains and in drainageways. Slopes are 0 to 2 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Cove silty clay loam, about 1.5 miles southwest of Canby, in the NE1/4SW1/4SW1/4 of sec. 6, T. 4 S., R. 1 E.

Ap—0 to 7 inches ; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; hard, firm, very sticky and very plastic; many very fine and fine roots; common very fine tubular pores; medium acid; clear smooth boundary.

B21g—7 to 18 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; very hard, firm, very sticky and very plastic; few very fine and fine roots; common very fine tubular pores; slightly acid; gradual smooth boundary.

B22g—18 to 43 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure; very hard, firm, very sticky and very plastic; common very fine tubular pores; common pressure faces; slightly acid; clear smooth boundary.

Cg—43 to 60 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; many fine distinct yellowish brown (10YR 5/6) mottles; massive; very hard, firm, very sticky and very plastic; common very fine tubular pores; slightly acid.

The mean annual soil temperature is 47 to 55 degrees F. These soils are saturated with water in winter. During summer the soil cracks at some depth above 20 inches and below the A horizon.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 or less when moist or dry.

The B horizon has hue of 10YR or 2.5Y, value of 2 to 4 when moist and 4 or 5 when dry, and chroma of 0 to 2 when moist or dry. It is silty clay or clay.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 to 6 when moist or dry. It is silty clay or clay.

Crutch Series

The Crutch series consists of deep, moderately well drained soils on stream terraces in the foothills of the Cascade Range. These soils formed in glacial outwash derived from andesite and basalt. Slopes are 0 to 5 percent. The mean annual precipitation is about 85 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Crutch cobbly loamy coarse sand, 0 to 5 percent slopes, about 300 feet west of the intersection of Welches Road and U.S. Highway 26, in the SE1/4SE1/4SE1/4 of sec. 32, T. 2 S., R. 7 E.

O1—2 inches to 1 inch; needles, twigs, leaves, and cones.

O2—1 inch to 0; decomposed organic matter containing many roots; strongly acid.

A2—0 to 2 inches; dark gray (10YR 4/1) cobbly loamy coarse sand, light gray (10YR 6/1) dry; single grain; loose, nonsticky and nonplastic; many fine and medium roots; many very fine and fine irregular pores; 15 percent cobbles and 10 percent gravel; strongly acid; abrupt wavy boundary.

B2ir—2 to 9 inches; dark brown (7.5YR 3/2) cobbly loamy coarse sand, brown (10YR 4/3) dry; common dark reddish brown (5YR 3/2) and very dark grayish brown (10YR 3/2) streaks; massive; soft, friable, nonsticky and nonplastic; many fine and medium roots; many very fine and fine irregular pores; 20 percent cobbles and 10 percent gravel; strongly acid; gradual wavy boundary.

B22ir—9 to 20 inches; dark brown (7.5YR 3/2) cobbly loamy coarse sand, brown (10YR 4/3) dry; common dark reddish brown (5YR 3/2) and very dark grayish brown (10YR 3/2) streaks; massive; soft, friable, nonsticky and nonplastic; many fine and medium

roots; many very fine irregular pores; 20 percent cobbles and 10 percent gravel; strongly acid; gradual wavy boundary.

B3ir—20 to 28 inches; brown (7.5YR 4/4) very cobbly loamy coarse sand, brown (10YR 5/3) dry; many fine and medium faint dark brown (10YR 3/3) and dark yellowish brown (10YR 4/4) mottles; massive; soft, friable, nonsticky and nonplastic; many fine and medium roots; many very fine and fine irregular pores; 35 percent cobbles and 20 percent gravel; strongly acid; abrupt wavy boundary.

C1—28 to 60 inches; dark brown (10YR 4/2), brown (10YR 5/3), yellowish brown (10YR 5/4), and gray (10YR 5/1) extremely cobbly loamy coarse sand, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) dry; massive; weakly consolidated; very hard, very firm, nonsticky and nonplastic; brittle; many very fine and fine irregular pores; 50 percent cobbles and 20 percent gravel; slightly acid.

The mean annual soil temperature is 47 to 52 degrees F. Depth to the weakly consolidated C horizon is 12 to 30 inches.

The A horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 0 or 1 when moist or dry. The horizon has 0 to 30 percent cobbles and gravel.

The B2ir horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 6 when moist or dry. It is loamy coarse sand or loamy sand. The horizon has 20 to 45 percent cobbles and 10 to 25 percent gravel.

The C1 horizon has hue of 10YR or 2.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 1 to 4 when moist or dry. It has 30 to 50 percent cobbles, 10 to 20 percent gravel, and 0 to 10 percent stones.

Crutch Variant

The Crutch Variant consists of deep, poorly drained soils that formed in glacial outwash. These soils are in slightly concave areas on stream terraces. Slopes are 0 to 3 percent. The mean annual precipitation is about 85 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Crutch Variant loamy coarse sand, about 0.5 mile northwest of Wemme, in the SW1/4NW1/4NE1/4 of sec. 32, T. 2 S., R. 7 E.

O2—3 inches to 0; black (10YR 2/1) decomposed organic matter.

A21—0 to 4 inches; dark grayish brown (10YR 4/2) loamy coarse sand, light gray (10YR 6/1) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine irregular pores; 5 percent gravel and 5 percent cobbles; medium acid; clear smooth boundary.

A22—4 to 9 inches; gray (10YR 5/1) gravelly loamy coarse sand, light gray (10YR 6/1) dry; many medium distinct dark brown (7.5YR 3/4) mottles; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine irregular pores; 20 percent gravel and 5 percent cobbles; medium acid; clear wavy boundary.

B21ir—9 to 15 inches; dark brown (7.5YR 3/4) and gray (10YR 5/1) very gravelly loamy coarse sand, strong brown (7.5YR 5/6) and light gray (10YR 6/1) dry; massive; hard, firm, nonsticky and nonplastic; slightly brittle; few fine roots; many very fine irregular pores; 25 percent gravel and 10 percent cobbles; strongly acid; clear smooth boundary.

B22ir—15 to 24 inches; dark brown (7.5YR 3/4) and gray (10YR 5/1) very cobbly loamy coarse sand, strong brown (7.5YR 5/6) and light gray (10YR 6/1) dry; massive; very hard, very firm, nonsticky and nonplastic; slightly brittle; many very fine irregular pores; 20 percent cobbles and 15 percent gravel; strongly acid; clear smooth boundary.

C—24 to 60 inches; grayish brown (10YR 5/2), weakly consolidated extremely cobbly coarse sand, light brownish gray (10YR 6/2) dry; 65 percent rock fragments.

These soils are saturated with water much of the time in winter and spring. The mean annual soil temperature is 48 to 50 degrees F. The A2 horizon is 4 to 10 inches thick. Depth to the C horizon is 15 to 24 inches.

The A2 horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 or less when moist or dry. It has 0 to 20 percent gravel and 0 to 20 percent cobbles.

The B2ir horizon has variegated hue of 7.5YR, 5YR, and 10YR. Where hue is 10YR, the horizon has value of 4 or 5 when moist and 6 or 7 when dry and chroma of 2 or less when moist or dry. Where hue is 7.5YR or 5YR, the horizon has value of 3 or 4 when moist and 4 or 5 when dry and chroma of 4 to 6 when moist or dry. The horizon is loamy coarse sand or loamy sand. It has 15 to 40 percent gravel and 0 to 20 percent cobbles.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 or less when moist or dry. It has 30 to 50 percent cobbles, 5 to 20 percent gravel, and 0 to 5 percent stones.

Dabney Series

The Dabney series consists of deep, somewhat excessively drained soils that formed in sandy alluvium derived from andesite. These soils are on stream terraces. Slopes are 0 to 3 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Dabney loamy sand, about 4 miles north of Sandy, in the SW1/4NW1/4NE1/4 of sec. 25, T. 1 S., R. 4 E.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many fine irregular pores; 10 percent cobbles; strongly acid; clear smooth boundary.

AC—5 to 18 inches; dark grayish brown (10YR 4/2) cobbly loamy sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; many very fine and fine roots; many fine irregular pores; 15 percent cobbles; medium acid; clear smooth boundary.

C1—18 to 35 inches; dark gray (10YR 4/1) gravelly coarse sand, gray (10YR 5/1) dry; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many fine irregular pores; 25 percent gravel; medium acid; clear smooth boundary.

C2—35 to 60 inches; dark grayish brown (10YR 4/2) gravelly sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; many fine irregular pores; 30 percent gravel; medium acid.

The mean annual soil temperature is 51 to 53 degrees F. Depth to bedrock is more than 60 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry. It has 0 to 15 percent cobbles.

The AC horizon has value of 3 or 4 when moist and 4 or 5 when dry. It is sand or loamy sand and has 0 to 15 percent cobbles.

The C horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 1 or 2 when moist or dry. The horizon is sand or coarse sand and has 0 to 30 percent gravel.

Dayton Series

The Dayton series consists of deep, poorly drained soils that formed in stratified glaciolacustrine deposits. These soils are on terraces. Slopes are 0 to 2 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Dayton silt loam, in the NW1/2SE1/4 of sec. 4, T. 5 S., R. 2 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common fine faint mottles; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many medium and fine irregular pores; medium acid; clear smooth boundary.

A1—7 to 15 inches; brown (10YR 4/3) silty clay loam, light brownish gray (10YR 6/2) dry; common fine distinct mottles; moderate coarse and medium subangular blocky structure; hard, firm, sticky and plastic; common fine roots; many coarse, medium, and fine tubular pores; medium acid; clear smooth boundary.

A2—15 to 21 inches; light brownish gray (10YR 6/2) silty clay loam, light gray (10YR 7/2) dry; common fine distinct mottles; weak thin platy structure; hard, firm, sticky and plastic; common fine roots; common fine tubular pores; thin patchy clay films; few fine concretions; medium acid; abrupt wavy boundary.

IIB2t—21 to 37 inches; dark grayish brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) dry; common fine distinct mottles; moderate medium prismatic structure; hard, very firm, very sticky and very plastic; common fine roots; few medium tubular pores; thin discontinuous clay films; few fine concretions; medium acid; gradual smooth boundary.

IIB3t—37 to 45 inches; dark grayish brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) dry; common fine distinct mottles; weak medium prismatic structure; hard, very firm, very sticky and very plastic; few fine roots; common fine and few medium tubular pores; continuous thin clay films on pressure faces; few gravel-size fragments; medium acid; clear smooth boundary.

IIC—45 to 60 inches; dark brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) dry; common fine distinct mottles; massive; very hard, very firm, very sticky and very plastic; thick clay films on vertical fractures; many manganese stains; medium acid.

These soils are saturated with water late in fall, in winter, and early in spring. The mean annual soil temperature is 51 to 55 degrees F. Depth to bedrock is more than 60 inches.

The Ap horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 1 to 3.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 1 or 2. It is silt loam or silty clay loam.

The IIBt horizon has hue of 2.5Y, 5Y, or neutral, value of 4 or 5 when moist, and chroma of 0 to 2. It is silty clay or clay and has 40 to 60 percent clay.

Delena Series

The Delena series consists of deep, poorly drained soils that have a hardpan. These soils are on rolling uplands and high terraces. They formed in mixed silty alluvium. Slopes are 3 to 12 percent. The mean annual precipitation is about 55 inches, and mean annual air temperature is about 52 degrees F.

Typical pedon of Delena silt loam, 3 to 12 percent slopes, about 2 miles northeast of Wilsonville, in the SW1/4NW1/4SW1/4 of sec. 6, T. 3 S., R. 1 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, gray (10YR 5/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine irregular pores; medium acid; abrupt smooth boundary.

A1—8 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine roots; many very fine tubular pores; common fine concretions; medium acid; clear smooth boundary.

B1—12 to 18 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; many fine prominent dark reddish brown (5YR 3/3) mottles; moderate fine subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common very fine tubular pores; common fine concretions; medium acid; clear smooth boundary.

B2—18 to 25 inches; grayish brown (10YR 5/2) silty clay loam, light gray (10YR 7/1) dry; many fine prominent reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; firm, hard, slightly sticky and plastic; slightly brittle; few very fine roots; common very fine tubular pores; medium acid; clear smooth boundary.

IIB1x—25 to 36 inches; grayish brown (10YR 5/2) silty clay loam, light gray (10YR 7/1) dry; many fine prominent reddish brown (5YR 4/4) mottles; weak coarse prismatic structure; firm, hard, sticky and plastic; brittle; common very fine tubular pores; common moderately thick clay films in pores; slightly acid; clear smooth boundary.

IIB2x—36 to 60 inches; variegated dark grayish brown (10YR 4/2 and 2.5Y 4/2) and yellowish red (5YR 4/6) silty clay loam; weak coarse prismatic structure; firm, hard, slightly sticky and plastic; slightly brittle; common very fine tubular pores; common moderately thick clay films in pores; slightly acid.

The mean annual soil temperature is 52 to 55 degrees F. Unless these soils are artificially drained, they are saturated with water in winter and spring. Thickness of the solum is 40 to 60 inches or more. Depth to bedrock is more than 60 inches. Depth to the IIBx horizon is 20 to 30 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 1 or 2 when moist or dry.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 when moist and 1 or 2 when dry. The horizon has distinct or prominent mottles. It is silt loam or silty clay loam.

The IIBx horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. The coatings on the peds and tongues have lower chroma and yellower hue.

Divers Series

The Divers series consists of deep, well drained soils that formed in colluvium derived from basalt and andesite mixed with volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 90 percent. The mean annual precipitation is about 85 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of a Divers gravelly loam in an area of Kinzel-Divers complex, 5 to 30 percent slopes, about 0.5 mile south of the old Peachuck Lookout, in the NW1/4NW1/4NW1/4 of sec. 35, T. 7 S., R. 4 E.

O1—1 inch to 0; needles, twigs, and cones.

A1—0 to 6 inches; dark brown (7.5YR 3/2) gravelly loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many fine irregular pores; 20 percent gravel and 5 percent cobbles; strongly acid; abrupt smooth boundary.

B1—6 to 15 inches; dark brown (7.5YR 4/4) gravelly loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine tubular pores; 25 percent gravel and 10 percent cobbles; strongly acid; clear smooth boundary.

B21—15 to 28 inches; dark brown (7.5YR 4/4) very cobbly loam, light brown (7.5YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; many very fine tubular pores; 30 percent cobbles and 25 percent gravel; medium acid; clear smooth boundary.

B22—28 to 42 inches; dark brown (7.5YR 4/4) very cobbly loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; many very fine tubular pores; 40 percent cobbles and 25 percent gravel; medium acid; clear smooth boundary.

IIC—42 to 60 inches; dark yellowish brown (10YR 4/4) extremely cobbly loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; 50 percent cobbles and 30 percent gravel; medium acid.

The mean annual soil temperature is 40 to 44 degrees F. The mean summer soil temperature is 47 degrees or less where an O horizon is present. Depth to bedrock is 60 inches or more.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. It has 15 to 30 percent gravel and 5 to 10 percent cobbles.

The B horizon has hue of 7.5YR or 5YR, value of 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is loam or silt loam and has 10 to 45 percent cobbles and 25 to 35 percent gravel.

The IIC horizon has hue of 10YR or 7.5YR. It is slightly brittle to brittle in some areas. The horizon has 25 to 50 percent cobbles, 20 to 30 percent gravel, and 0 to 10 percent stones.

Fernwood Series

The Fernwood series consists of moderately deep, well drained soils that formed in colluvium derived from andesite and basalt mixed with volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 90 percent. The mean annual precipitation is about 80 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Fernwood very gravelly loam, 5 to 30 percent slopes, about 6 miles west of Table Rock, in the NW1/4NE1/4NE1/4 of sec. 9, T. 7 S., R. 3 E.

O1—1 inch to 0; partially decomposed needles, leaves, and twigs.

A11—0 to 4 inches; very dark grayish brown (10YR 3/2) very gravelly loam, dark brown (10YR 3/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, fine, and coarse roots; many fine irregular pores; 35 percent gravel and 15 percent cobbles; strongly acid; clear smooth boundary.

A12—4 to 10 inches; very dark grayish brown (10YR 3/2) very gravelly loam, dark brown (10YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, fine, and coarse roots; many very fine tubular pores; 30 percent gravel and 10 percent cobbles; strongly acid; clear wavy boundary.

B21—10 to 17 inches; dark brown (10YR 4/3) very cobbly loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; common very fine and fine roots and few medium roots; many very fine tubular pores; 40 percent cobbles and 10 percent gravel; strongly acid; gradual wavy boundary.

B22—17 to 25 inches; dark brown (10YR 4/3) very cobbly loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; few fine and medium roots; many very fine tubular pores; 50 percent cobbles and 10 percent gravel; strongly acid; clear wavy boundary.

R—25 inches; fractured andesite.

The mean annual soil temperature is 43 to 47 degrees F. Depth to bedrock is 20 to 40 inches.

The A horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 1 to 3 when moist or dry. It has 20 to 35 percent gravel and 5 to 25 percent cobbles.

The B horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist or dry. It is loam, silt loam, or clay loam and has 10 to 25 percent gravel and 25 to 40 percent cobbles.

Gapcot Series

The Gapcot series consists of shallow, well drained soils that formed in colluvium derived from sandstone. These soils are on rolling uplands. Slopes are 3 to 60 percent. The mean annual precipitation is about 55 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Gapcot gravelly loam, 3 to 30 percent slopes, about 2 miles southeast of Marquam, in the NW1/4NW1/4SE1/4 of sec. 11, T. 6 S., R. 1 E.

Ap1—0 to 4 inches; dark brown (7.5YR 3/3) gravelly loam, brown (10YR 5/3) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; 25 percent sandstone gravel; slightly acid; clear smooth boundary.

Ap2—4 to 10 inches; dark brown (7.5YR 3/3) gravelly loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; 30 percent sandstone gravel; medium acid; clear smooth boundary.

B2—10 to 15 inches; brown (7.5YR 4/4) gravelly clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and plastic; common very fine and fine roots; many very fine tubular pores; 15 percent sandstone gravel; medium acid; abrupt smooth boundary.

R—15 inches; fractured sandstone.

The mean annual soil temperature is 50 to 52 degrees F. Depth to fractured sandstone is 10 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. It has 10 to 30 percent gravel.

The B horizon has hue of 7.5YR, 10YR, or 5YR, and it has value of 4 or 5 when moist and 6 or 7 when dry. It is clay loam or loam and has 10 to 35 percent gravel.

Hardscrabble Series

The Hardscrabble series consists of deep, somewhat poorly drained soils that formed in clayey alluvium. These soils are on uplands. Slopes are 2 to 20 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Hardscrabble silt loam, 2 to 7 percent slopes, about 3 miles east of Canby, in the NE1/4SE1/4NE1/4 of sec. 1, T. 4 S., R. 1. E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, pale brown (10YR 6/3) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; medium acid; abrupt smooth boundary.

B1—8 to 14 inches; dark brown (10YR 4/3) silty clay loam, pale brown (10YR 7/3) dry; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; very strongly acid; abrupt wavy boundary.

IIB21t—14 to 24 inches; brown (10YR 5/3) clay, very pale brown (10YR 7/3) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; common moderately thick clay films; very strongly acid; clear wavy boundary.

IIB22t—24 to 33 inches; brown (10YR 5/3) clay, very pale brown (10YR 7/3) dry; common fine distinct yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; weak coarse prismatic structure and weak coarse subangular blocky; very hard, very firm, very sticky and very plastic; few very fine roots; common very fine tubular pores; common moderately thick clay films; very strongly acid; clear wavy boundary.

IIB3—33 to 60 inches; brown (10YR 5/3) clay, very pale brown (10YR 7/3) dry; dark gray (10YR 4/1) coatings; common fine distinct yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; moderate coarse angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; common very fine tubular pores; very strongly acid.

The mean annual soil temperature is 52 to 56 degrees F. Thickness of the solum is 35 to 60 inches or more. Depth to bedrock is more than 60 inches.

The A horizon has hue of 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry.

The IIBt horizon has hue of 10YR or 2.5YR, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 2 or 3 when moist or dry. The horizon is mainly clay or silty clay, but in some areas it is silty clay loam in the lower part. The horizon has 50 to 60 percent clay and 0 to 15 percent gravel and cobbles.

Helvetia Series

The Helvetia series consists of deep, moderately well drained soils on high terraces. These soils formed in mixed old alluvium. Slopes are 3 to 30 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Helvetia silt loam, 8 to 15 percent slopes, about 3 miles southwest of Wilsonville, in the SW1/4SE1/4NW1/4 of sec. 29, T. 3 S., R. 1 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine irregular pores; medium acid; abrupt smooth boundary.

A1—7 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine irregular pores; medium acid; clear smooth boundary.

B1—14 to 21 inches; dark brown (10YR 3/3) silty clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; many very fine and fine roots; common very fine and fine tubular pores; medium acid; clear smooth boundary.

B21t—21 to 30 inches; brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; many fine roots and few medium roots; many very fine and fine tubular pores; common moderately thick clay films on peds; medium acid; clear smooth boundary.

B22t—30 to 40 inches; brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; many very fine and fine tubular pores; common moderately thick clay films on peds; strongly acid; gradual smooth boundary.

B3—40 to 60 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; weak moderate subangular blocky structure; hard, friable, sticky and plastic; many very fine and fine tubular pores; strongly acid.

The mean annual soil temperature is 54 to 56 degrees F. Depth to bedrock is more than 60 inches. Faint mottles and black stains are below a depth of 30 inches

in some areas. Base saturation in all or part of the upper 30 inches is less than 75 percent.

The A horizon has chroma of 2 or 3 when moist or dry.

The Bt horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 2 to 4 when moist or dry. It has thin or moderately thick, common or continuous clay films on the faces of peds. The Bt horizon is mainly silty clay, but it ranges to silty clay loam. It has 35 to 50 percent clay.

Highcamp Series

The Highcamp series consists of deep, well drained soils that formed in colluvium derived from andesite mixed with volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 90 percent. The mean annual air temperature is about 42 degrees F, and the mean annual precipitation is about 85 inches.

Typical pedon of Highcamp very gravelly loam, 30 to 60 percent slopes, about 2 miles southwest of Highcamp Lookout, in the NE1/4SE1/4SW1/4 of sec. 36, T. 6 S., R. 3 E.

O1—2 inches to 0; partially decomposed leaves, needles, and twigs.

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) very gravelly loam, brown (10YR 5/3) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, fine, medium, and coarse roots; many very fine irregular pores; many fine concretions; 30 percent gravel and 10 percent cobbles; medium acid; gradual smooth boundary.

A3—8 to 17 inches; dark brown (10YR 3/3) very cobbly loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, fine, medium, and coarse roots; many very fine tubular pores; 25 percent cobbles and 20 percent gravel; medium acid; clear smooth boundary.

B21—17 to 27 inches; brown (10YR 4/3) very cobbly loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; common very fine, fine, medium, and coarse roots; many very fine tubular pores; 30 percent cobbles and 15 percent gravel; strongly acid; clear smooth boundary.

B22—27 to 39 inches; brown (10YR 5/3) very cobbly loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine, fine, medium, and coarse roots; many very fine tubular pores; 40 percent cobbles and 20 percent gravel; strongly acid; abrupt wavy boundary.

C—39 to 45 inches; yellowish brown (10YR 5/4) extremely cobbly loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine tubular pores; 75 percent cobbles and 10 percent gravel; strongly acid; clear smooth boundary.

R—45 inches; fractured andesite.

The mean annual soil temperature is 42 to 46 degrees F. Where the soil has an O horizon, the mean summer soil temperature is less than 47 degrees. Depth to fractured bedrock is 40 to 60 inches or more.

The A horizon has hue of10YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. It is loam or silt loam and has 20 to 30 percent gravel and 10 to 25 percent cobbles.

The B horizon has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is loam or silt loam and has 20 to 40 percent cobbles and 15 to 30 percent gravel.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is loam or silt loam and has 50 to 75 percent cobbles and 0 to 15 percent gravel.

Huberly Series

The Huberly series consists of deep, poorly drained soils on terraces. These soils formed in stratified glaciolacustrine deposits. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Huberly silt loam; about 1 mile north of Gladstone, along Naef Road; in the SE1/4NE1/4NE1/4 of sec. 13, T. 2 S., R. 1 E.

A1—0 to 8 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 6/1) dry; few faint dark gray (10YR 4/1) mottles; strong fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

B1—8 to 15 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; many fine faint dark gray (10YR 4/1) and reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine and fine tubular pores; medium acid; clear smooth boundary.

B2—15 to 24 inches; grayish brown (10YR 5/2) heavy silt loam, light gray (10YR 7/2) dry; many fine distinct dark brown (7.5YR 4/2) and yellowish red (5YR 4/6) mottles; moderate coarse and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

IIBx—24 to 35 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; common fine distinct brown (7.5YR 4/4) mottles; weak coarse subangular blocky structure; hard, firm, nonsticky and slightly plastic; brittle; thick grayish brown (10YR5/2) sand and silt coatings on faces of peds; many very fine tubular pores; few fine black stains; medium acid; clear smooth boundary.

IICx—35 to 60 inches; variegated gray (10YR 5/1), brown (10YR 5/3), dark grayish brown (10YR 4/2), and dark brown (10YR 4/3) silt loam; massive; hard, firm, slightly sticky and slightly plastic; brittle; many fine tubular pores; few black stains; medium acid.

The mean annual soil temperature is 54 to 56 degrees F. Unless these soils are artificially drained, they are saturated with water in winter. Thickness of the solum is 24 to 40 inches. Depth to bedrock is more than 60 inches. Depth to the IIBx horizon is 20 to 30 inches.

The A horizon has value of 3 or 4 when moist and 6 when dry, and it has chroma of 1 or 2 when moist or dry.

The B2 horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 7 when dry, and chroma of 2 to 4 when moist or dry. It is heavy silt loam or silty clay loam and has 27 to 35 percent clay.

Jimbo Series

The Jimbo series consists of deep, well drained soils on terraces. These soils formed in mixed alluvium and volcanic ash. Slopes are 0 to 5 percent. The mean annual precipitation is about 85 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Jimbo loam, cool, 0 to 5 percent slopes; 1 mile southwest of Zigzag, near Bowman's Golf Course; in the NW1/4SW1/4SW1/4 of sec. 4, T. 3 S., R. 7 E.

A11—0 to 7 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate very fine granular structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

A12—7 to 18 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

B2—18 to 29 inches; dark yellowish brown (10YR 3/4) loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

C1—29 to 47 inches; dark yellowish brown (10YR 3/4) sandy loam, brown (10YR 5/3) dry; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; few fine tubular pores; 10 percent gravel; slightly acid; clear wavy boundary.

IIC2—47 to 60 inches; dark yellowish brown (10YR 4/4) very cobbly sand, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard, very friable, nonsticky and nonplastic; 35 percent cobbles and 15 percent gravel; slightly acid.

The mean annual soil temperature is 47 to 51 degrees F. Depth to the IIC horizon is 40 to 60 inches or more. Depth to bedrock is more than 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is loam or fine sandy loam and averages less than 18 percent clay and more than 15 percent material that is coarser textured than very fine sand.

The C horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It has 30 to 50 percent cobbles and 10 to 20 percent gravel.

Jory Series

The Jory series consists of deep, well drained soils that formed in colluvium. These soils are on rolling uplands. Slopes are 2 to 60 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Jory silty clay loam, 2 to 8 percent slopes, at the intersection of Newkirchner and Union Hall Roads, in the NE1/4NE1/4SW1/4 of sec. 9, T. 4 S., R.2 E.

Ap—0 to 7 inches; dark brown (7. 5YR 3/3) silty clay loam, brown (7.5YR 4/3) dry; strong fine subangular blocky structure; hard, friable, sticky and slightly plastic; many fine roots; many fine irregular pores; many coarse, medium, and fine concretions; medium acid; abrupt smooth boundary.

B1t—7 to 13 inches; dark reddish brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) dry; moderate medium and fine subangular blocky structure; hard, firm, sticky and plastic; many fine roots; many fine irregular pores; few thick patchy clay films in pores; medium acid; clear smooth boundary.

B21t—13 to 20 inches; dark red (2.5YR 3/6) silty clay, red (2.5YR 4/6) dry; moderate medium and fine subangular blocky structure; hard, firm, very sticky and very plastic; common fine roots; many fine tubular pores; common moderately thick clay films; medium acid; gradual wavy boundary.

B22t—20 to 43 inches; yellowish red (5YR 3/6) silty clay, yellowish red (5YR 4/6) dry; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; few fine roots; many fine tubular pores; continuous moderately thick clay films; common fine black stains; medium acid; gradual wavy boundary.
B3t—43 to 60 inches; dark reddish brown (2.5YR 3/4) and dark red (2.5YR 3/6) silty clay, red (2.5YR 4/6) dry; weak coarse and medium subangular blocky structure; very hard, very firm, very sticky and very plastic; many fine tubular pores; continuous thin and thick clay films in pores; many fine and medium black stains; strongly acid.

The mean annual soil temperature is 52 to 54 degrees F. Depth to bedrock is more than 60 inches. Thickness of the solum commonly is 60 inches or more. In some pedons the profile is stony throughout.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 3 or 4 when moist and 3 to 6 when dry. It is medium acid or strongly acid.

The B2t horizon has hue of 2.5YR or 5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 4 to 6 when moist or dry. It is about 45 to 60 percent clay. The horizon is medium acid or strongly acid.

Kinney Series

The Kinney series consists of deep, well drained soils that formed in colluvium derived from tuff and breccia. These soils are on rolling uplands. Slopes are 2 to 50 percent. The mean annual precipitation is about 75 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Kinney cobbly loam, 3 to 20 percent slopes, in the NW1/4SW1/4SE1/4 of sec. 27, T. 4 S., R. 4 E.

O1—1 inch to 0; duff.
A11—0 to 11 inches; very dark grayish brown (10YR 3/2) cobbly loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine irregular pores; 15 percent gravel and 20 percent cobbles; slightly acid; clear smooth boundary.
A12—11 to 19 inches; dark brown (10YR 3/3) cobbly loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 10 percent gravel and 25 percent cobbles; medium acid; clear smooth boundary.
B2—19 to 28 inches; dark brown (7.5YR 4/4) cobbly clay loam, brown (7.5YR 5/4)dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and plastic; many very fine roots; many very fine tubular pores; 15 percent cobbles; very strongly acid; clear smooth boundary.
B3—28 to 41 inches; dark brown (7.5YR 4/4) cobbly loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 15 percent cobbles; very strongly acid; clear smooth boundary.
C—41 to 60 inches; brown (10YR 4/3) cobbly loam, yellowish brown (10YR 5/4) dry; massive; hard, firm, slightly sticky and slightly plastic; 10 percent gravel and 15 percent cobbles; very strongly acid.

The mean annual soil temperature is 47 to 52 degrees F. Depth to bedrock is 40 to 60 inches or more.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It has 0 to 25 percent gravel and 0 to 25 percent cobbles.

The B horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist or dry. It is cobbly loam, loam, or clay loam and has 0 to 20 percent cobbles and 0 to 15 percent gravel.

The C horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 to 6 when moist or dry.

Kinton Series

The Kinton series consists of deep, moderately well drained soils that have a hardpan. These soils are on rolling uplands. They formed in stratified glaciolacustrine deposits. Slopes are 3 to 60 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Kinton silt loam, 8 to 15 percent slopes, 0.5 mile northeast of Lakeridge High School, in the SE1/4NW1/4NW1/4 of sec. 15, T. 2 S., R. 1 E.

Ap—0 to 7 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; many fine irregular pores; medium acid; abrupt smooth boundary.
A1—7 to 15 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; many very fine tubular pores; medium acid; clear smooth boundary.
B1—15 to 22 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium and coarse roots; many very fine tubular pores; common

fine concretions; medium acid; clear smooth boundary.
B2—22 to 35 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few medium and coarse roots; many very fine tubular pores; few fine concretions; medium acid; clear smooth boundary.
IIB1x—35 to 46 inches; brown (10YR 4/3) silt loam, light yellowish brown (10YR 6/4) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; firm, slightly sticky and plastic; brittle; many very fine tubular pores; few grayish brown (10YR 5/2) coatings on faces of some peds; strongly acid; gradual smooth boundary.
IIB2x—46 to 55 inches; brown (10YR 4/3) silt loam, light yellowish brown (10YR 6/4) dry; grayish brown (10YR 5/2) tongues about 1 foot apart; many strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; very firm, slightly sticky and slightly plastic; brittle; many very fine tubular pores; many fine black stains; strongly acid; gradual wavy boundary.
IICx—55 to 65 inches; brown (10YR 4/3) silt loam, light yellowish brown (10YR 6/4) dry; grayish brown (10YR 5/2) tongues about 1 foot apart; many yellowish brown (10YR 5/6) mottles; massive; very firm, slightly sticky and slightly plastic; brittle; few very fine tubular pores; medium acid.

The mean annual soil temperature is 52 to 56 degrees F. The solum is 40 to 60 inches thick or more. Depth to the hardpan is 30 to 40 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The B horizon has value of 4 when moist and 5 or 6 when dry, and it has chroma of 3 when moist and 3 or 4 when dry.

The IIBx horizon has value of 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. It has few to many distinct mottles. Grayish brown tongues are 6 to 24 inches apart.

Kinzel Series

The Kinzel series consists of deep, well drained soils that formed in colluvium derived from andesite and basalt mixed with volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 90 percent. The mean annual precipitation is about 85 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of a Kinzel very gravelly loam in an area of Kinzel-Divers complex, 5 to 30 percent slopes, about 2 miles east of Highcamp Lookout, in the SW1/4SW1/4SW1/4 of sec. 26, T. 6 S., R. 4 E.

O2—1 inch to 0; decomposed organic matter.
A11—0 to 6 inches; very dark grayish brown (10YR 3/2) very gravelly silt loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common fine irregular pores; 15 percent cobbles and 35 percent gravel; strongly acid; clear smooth boundary.
A12—6 to 17 inches; dark brown (10YR 3/3) very gravelly silt loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common fine tubular pores; 15 percent cobbles and 35 percent gravel; medium acid; clear smooth boundary.
B21—17 to 26 inches; brown (10YR 4/3) extremely cobbly loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common fine tubular pores; 40 percent gravel and 30 percent cobbles; strongly acid; clear smooth boundary.
B22—26 to 43 inches; brown (10YR 4/3) extremely cobbly loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common fine tubular pores; 50 percent cobbles and 25 percent gravel; medium acid; gradual smooth boundary.
C—43 to 60 inches; brown (10YR 4/3) extremely cobbly loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine tubular pores; 50 percent cobbles and 15 percent gravel; medium acid.

The mean annual soil temperature is 42 to 47 degrees F, and the mean summer soil temperature is less than 47 degrees F. Depth to bedrock or cemented till dominantly is more than 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 to 3 when moist or dry. It has 30 to 50 percent gravel and 10 to 30 percent cobbles.

The B horizon has hue of 10YR or 7.5YR, value of 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is loam, silt loam, or sandy loam and has 25 to 50 percent gravel and 20 to 50 percent cobbles.

The C horizon has hue of 10YR or 7.5YR, value of 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is loam, sandy loam, or silt loam and has 15 to 60 percent gravel and 20 to 50 percent cobbles.

Klickitat Series

The Klickitat series consists of deep, well drained soils that formed in colluvium derived from andesite and

basalt. These soils are on mountainous uplands. Slopes are 5 to 60 percent. The mean annual precipitation is about 75 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Klickitat stony loam, 30 to 60 percent slopes, about 2 miles northwest of the Bee Ranch, in the SE1/4SE1/4SW1/4 of sec. 9, T. 7. S., R. 3 E.

O1—1 inch to 0; layer of needles and twigs.
A1—0 to 7 inches; dark brown (7.5YR 3/2) stony loam, brown (7.5YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; 25 percent gravel and 5 percent stones; strongly acid; clear smooth boundary.
A3—7 to 15 inches; dark reddish brown (5YR3/3) stony loam, reddish brown (5YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, medium, and coarse roots; many very fine tubular pores; 20 percent gravel, 5 percent cobbles, and 5 percent stones; strongly acid; clear smooth boundary.
B21—15 to 28 inches; dark reddish brown (5YR 3/4) very gravelly clay loam, reddish brown (5YR 4/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine, fine, medium, and coarse roots; many very fine tubular pores; 40 percent gravel and 10 percent cobbles; strongly acid; clear wavy boundary.
B22—28 to 35 inches; reddish brown (5YR 4/4) very cobbly clay loam, yellowish red (5YR 5/6) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; common fine and medium roots; many very fine tubular pores; 30 percent gravel and 30 percent cobbles; strongly acid; clear smooth boundary.
C—35 to 48 inches; reddish brown (5YR 5/4) extremely cobbly loam, yellowish red (5YR 5/6) dry; massive; hard, firm, slightly sticky and slightly plastic; common fine irregular pores; 40 percent cobbles and 30 percent gravel; very strongly acid; abrupt wavy boundary.
R—48 inches; andesite.

The mean annual soil temperature is 47 to 55 degrees F. Depth to bedrock is 40 to 60 inches or more.

The A horizon has hue of 7.5YR or 5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 3 or 4 when dry. It has 5 to 15 percent stones, 0 to 10 percent cobbles, and 5 to 20 percent gravel.

The B horizon has value of 3 or 4 when moist and 4 to 6 when dry, and it has chroma of 3 to 6 when moist or dry. It is clay loam or loam and has 10 to 40 percent gravel and 10 to 40 percent cobbles.

The C horizon has hue of 7.5YR or 5YR, value of 4 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist or dry. It is loam or clay loam and has 30 to 50 percent cobbles and 20 to 35 percent gravel.

Lastance Series

The Lastance series consists of deep, well drained soils that formed in colluvium derived from andesite and basalt. These soils are on mountainous uplands. Slopes are 5 to 60 percent. The mean annual precipitation is about 95 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of a Lastance stony fine sandy loam in an area of Talapus-Lastance complex, 5 to 30 percent slopes, about 5 miles northeast of Table Rock, in the NE1/4NE1/4NE1/4 of sec. 8, T. 7 S., R. 5 E.

O1—2 inches to 1 inch; needles, twigs, and cones.
O2—1 inch to 0; very dark brown (10YR 2/2) decomposed organic matter.
A2—0 to 1 inch; gray (10YR 5/1) stony fine sandy loam, light gray (10YR 6/1) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine and fine irregular pores; 15 percent gravel, 5 percent cobbles, and 5 percent stones; very strongly acid; abrupt smooth boundary.
B21ir—1 inch to 2 inches; reddish brown (5YR 4/4) stony fine sandy loam, brown (7.5YR 5/4) dry; massive; hard, firm, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine irregular pores; 10 percent cobbles, 5 percent stones, and 20 percent gravel; strongly acid; abrupt wavy boundary.
B22ir—2 to 14 inches; variegated dark brown (7.5YR 4/4), grayish brown (10YR 5/2), and reddish brown (5YR 4/4) stony fine sandy loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine tubular pores; 25 percent cobbles and 5 percent stones; strongly acid; clear smooth boundary.
C—14 to 60 inches; dark brown (10YR 4/3) very cobbly fine sandy loam, brown (10YR 5/3) dry; massive; hard, very firm, slightly sticky and slightly plastic; few very fine, fine, and medium roots; many very fine irregular pores; 25 percent gravel and 30 percent cobbles; strongly acid.

The mean annual soil temperature is 40 to 45 degrees F. The mean summer soil temperature is 47 degrees or less in areas where an O horizon is present. Depth to bedrock is 60 inches or more.

The A2 horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 1 or less when

moist or dry. It has 15 to 30 percent gravel, 5 to 10 percent cobbles, and 5 to 10 percent stones.

The B2ir horizon has hue of 5Y R or 2.5YR in the upper part and 10YR, 7.5YR, or 5YR in the lower part. The horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 2 to 4 when moist or dry. It has 5 to 30 percent cobbles, 20 to 30 percent gravel, and 0 to 5 percent stones.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It has 35 to 50 percent gravel and 15 to 35 percent cobbles.

Latourell Series

The Latourell series consists of deep, well drained soils on terraces. These soils formed in stratified glaciolacustrine deposits. Slopes are 0 to 30 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Latourell loam, 0 to 3 percent slopes, about 2 miles northeast of Canby, in the SW1/4NW1/4NW1/4 of sec. 26, T. 3 S., R. 1 E.

Ap—0 to 6 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine irregular pores; medium acid; abrupt smooth boundary.

A1—6 to 15 inches; dark brown (10YR 3/3) loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

B21t—15 to 25 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry ; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few moderately thick clay films; medium acid; gradual wavy boundary.

B22t—25 to 48 inches; dark yellowish brown (10YR 4/4) heavy loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; common moderately thick clay films; medium acid; gradual smooth boundary.

IIC—48 to 60 inches; dark yellowish brown (10YR 4/4) gravelly sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, firm, nonsticky and nonplastic; many very fine tubular pores; 25 percent gravel; slightly acid.

The mean annual soil temperature is 54 to 56 degrees F. The solum is 30 to 50 inches thick. Depth to bedrock is more than 60 inches.

The A horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry.

The B2t horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. It is loam or heavy loam and has 18 to 27 percent clay.

The IIC horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 3 to 6 when moist or dry. It is gravelly sandy loam or very gravelly sandy loam and has 25 to 40 percent gravel.

Laurelwood Series

The Laurelwood series consists of deep, well drained soils on rolling uplands. These soils formed in silty material over older clayey material. Slopes are 3 to 60 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Laurelwood silt loam, 3 to 8 percent slopes, 1 mile southwest of Stafford, in the NW1/4NE1/4SW1/4 of sec. 31, T. 2 S., R. 1 E.

Ap1—0 to 3 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine irregular pores; many medium concretions; strongly acid; abrupt smooth boundary.

Ap2—3 to 10 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; many fine irregular pores; many medium concretions; medium acid; abrupt smooth boundary.

B1—10 to 18 inches; dark brown (7.5YR 3/4) silty clay loam, brown (7.5YR 4/4) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; many very fine and fine tubular pores; few fine concretions; medium acid; clear smooth boundary.

B21t—18 to 27 inches; dark brown (7.5YR 3/4) silty clay loam, brown (7.5YR 4/4) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; many very fine tubular pores; many thin clay films; strongly acid; clear smooth boundary.

B22t—27 to 46 inches; dark brown (7.5YR 3/4) silty clay loam, brown (7.5YR 4/4) dry; moderate coarse and medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; common very fine tubular pores; many thin and common moderately thick clay films; strongly acid; abrupt smooth boundary.

IIB3t—46 to 60 inches; dark reddish brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) dry; weak

medium subangular blocky structure; very hard, firm, sticky and plastic; few very fine tubular pores; few thin clay films in pores; strongly acid.

The mean annual soil temperature is 52 to 54 degrees F. Depth to the IIBt horizon is 40 to 60 inches or more. Depth to bedrock is 60 inches or more.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The Bt horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist or dry. The IIBt horizon has hue of 5YR or 7.5YR. It is silty clay or clay and has 0 to 20 percent gravel.

Malabon Series

The Malabon series consists of deep, well drained soils that formed in mixed silty and clayey alluvium. These soils are on low stream terraces. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Malabon silty clay loam, about 2 miles west of Mulino, in the NW1/4SW1/4SW1/4 of sec. 18, T. 4 S., R. 2 E.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine irregular pores; medium acid; abrupt smooth boundary.

A3—8 to 15 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; strong fine granular structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

B21t—15 to 24 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; many very fine tubular pores; few thin clay films; medium acid; clear smooth boundary.

B22t—24 to 35 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; many very fine tubular pores; many moderately thick clay films; medium acid; clear smooth boundary.

B3t—35 to 48 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; many very fine tubular pores; common moderately thick clay films; slightly acid; abrupt smooth boundary.

IIC—48 to 60 inches; brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; massive; slightly hard, firm, slightly sticky and slightly plastic; common very fine tubular pores; slightly acid.

The mean annual soil temperature is 52 to 55 degrees F. The mollic epipedon is 20 to 30 inches thick. The profile has 0 to 15 percent rock fragments.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist and 3 or 4 when dry. It is silty clay loam, silty clay, or clay loam. The horizon has common or many, moderately thick or thick clay films.

The C horizon has hue of10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist or dry. It is clay loam, loam, silty clay loam, or gravelly loam. Few faint mottles are below a depth of 48 inches in some pedons.

McBee Series

The McBee series consists of deep, moderately well drained soils that formed in mixed alluvium. These soils are on flood plains. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of McBee silty clay loam, about 1 mile north of Monitor, in the SE1/4NW1/4NE1/4 of sec. 25, T. 5 S., R. 1 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine granular structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; many very fine tubular pores; medium acid; abrupt smooth boundary.

A1—7 to 15 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

B1—15 to 24 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; strong fine subangular blocky structure; slightly hard, friable, sticky and plastic; common fine roots; many very fine tubular pores; slightly acid; gradual smooth boundary.

B2—24 to 35 inches; mottled, dark brown, very dark brown, and very dark grayish brown (10YR 3/3, 2/2, 3/2) silty clay loam, grayish brown and brown (10YR 4/2, 4/3) dry; moderate coarse and medium subangular blocky structure; hard, friable, sticky and

plastic; few fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

B3—35 to 48 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; many medium brown and dark yellowish brown (10YR 3/3, 4/4) mottles and common fine strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; many very fine tubular pores; slightly acid; clear smooth boundary.

Cg—48 to 60 inches; dark gray (10YR 4/1) clay loam, gray (10YR 5/1) dry; many fine distinct dark brown (10YR 3/3) mottles; massive; hard, firm, sticky and plastic; many very fine tubular pores; slightly acid.

The mean annual soil temperature is 53 to 55 degrees F. The solum is 30 to 50 inches thick. Depth to bedrock is more than 60 inches. Mottles that have chroma of 2 or less are at a depth of less than 30 inches. The mollic epipedon is 20 to 40 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 10YR or 7.5YR, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is silty clay loam or clay loam. The lower part of the horizon has 0 to 20 percent gravel.

The Cg horizon has hue of 10YR or 2.5Y, and it has chroma of less than 2. It is clay loam or clay and has 0 to 30 percent gravel.

McBee Variant

The McBee Variant consists of deep, somewhat poorly drained soils on flood plains. These soils formed in mixed alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of McBee Variant loam, about 2 miles southwest of Canby, in the NW1/4SE1/4NE1/4 of sec. 12, T. 4 S., R. 1 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine irregular pores; slightly acid; clear smooth boundary .

A1—7 to 14 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; slightly hard, friable, slightly sticky and slightly plastic; many very fine tubular pores; slightly acid; clear smooth boundary.

B1—14 to 28 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; many fine faint reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many very fine tubular pores; medium acid; gradual smooth boundary.

B21—28 to 42 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; many medium distinct reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; many very fine tubular pores; medium acid; gradual smooth boundary.

B22—42 to 60 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; many medium distinct reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; many very fine tubular pores; medium acid.

The mean annual soil temperature is 53 to 55 degrees F. The mollic epipedon is 10 to 20 inches thick. Depth to mottles is 10 to 20 inches.

The A horizon has value of 2 or 3 when moist and 3 to 5 when dry, and it has chroma of 2 or 3 when moist or dry. The profile generally is free of gravel, but the content of gravel ranges to 20 percent.

The B2 horizon has hue of 10YR or 2.5Y, value of 4 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist or dry. It is clay loam, loam, or sandy clay loam and has 0 to 20 percent gravel.

The McBee Variant soils differ from the soils in the McBee series by having a water table at a shallower depth and by having more than 15 percent sand that is coarser textured than very fine sand. These differences, however, do not significantly effect use and management.

McCully Series

The McCully series consists of deep, well drained soils that formed in colluvium derived from andesite and basalt. These soils are on rolling uplands. Slopes are 2 to 50 percent. The mean annual precipitation is about 70 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of McCully gravelly loam, 15 to 30 percent slopes, about 7 miles southeast of Dickey Prairie, in the SW1/4NW1/4NE1/4 of sec. 29, T. 6 S., R. 3 E.

A11—0 to 6 inches; dark brown (7.5YR 3/2) gravelly loam, brown (7.5YR 4/3) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine interstitial pores; 25 percent gravel; medium acid; clear smooth boundary.

A12—6 to 17 inches; dark reddish brown (5YR 3/3) gravelly loam, brown (7.5YR 4/3) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine tubular

pores; 15 percent gravel; medium acid; clear smooth boundary.
B1—17 to 29 inches; dark reddish brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) dry; strong medium subangular blocky structure; hard, friable, sticky and plastic; common very fine, fine, and medium roots; many very fine tubular pores; medium acid; clear smooth boundary.
B21—29 to 42 inches; yellowish red (5YR 4/6) silty clay, yellowish red (5YR 5/6) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; common fine and medium roots; many very fine tubular pores; medium acid; clear smooth boundary.
B22—42 to 56 inches; yellowish red (5YR 4/6) silty clay, red (2.5YR 5/6) dry; strong medium subangular blocky structure; hard, very firm, sticky and plastic; common fine and medium roots; many very fine tubular pores; few moderately thick clay films; common fine black concretions; strongly acid; clear smooth boundary.
B23—56 to 68 inches; yellowish red (5YR 4/6) silty clay, yellowish red (5YR 5/6) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; many very fine tubular pores; few moderately thick clay films; 10 percent weathered gravel; strongly acid.

The mean annual soil temperature is 48 to 53 degrees F. The umbric epipedon is 10 to 20 inches thick. Depth to bedrock is 40 to 60 inches or more.

The A horizon has hue of 7.5YR or 5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It has 0 to 25 percent gravel and 0 to 5 percent cobbles.

The B horizon has hue of 5YR or 2.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 4 to 6 when moist or dry. It is silty clay, silty clay loam, or clay and has 0 to 25 percent gravel and 0 to 10 percent cobbles.

Memaloose Series

The Memaloose series consists of moderately deep, well drained soils that formed in colluvium derived from tuff and breccia. These soils are on mountainous uplands. Slopes are 5 to 30 percent. The mean annual precipitation is about 80 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Memaloose loam, 5 to 30 percent slopes, about 4 miles west of Highcamp Lookout, in the SE1/4SE1/4NE1/4 of sec. 34, T. 6 S., R. 3 E.

A1—0 to 7 inches; dark reddish brown (5YR 3/3) loam, reddish brown (5YR 5/4) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, fine, and medium roots; many fine irregular pores; many small concretions; 10 percent gravel; strongly acid; clear smooth boundary.
A3—7 to 12 inches; dark reddish brown (2.5YR 3/4) loam, reddish brown (5YR 5/4) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine and fine roots; many very fine tubular pores; many small concretions; 10 percent gravel; strongly acid; clear smooth boundary.
B21—12 to 25 inches; dark reddish brown (2.5YR 3/4) clay loam, reddish brown (2.5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and plastic; few very fine and fine roots; many very fine tubular pores; 10 percent gravel; strongly acid; clear smooth boundary.
B22—25 to 36 inches; dark red (2.5YR 3/6) clay loam, red (2.5YR 5/6) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common coarse roots and few fine and medium roots; many very fine tubular pores; 10 percent gravel and 5 percent cobbles; strongly acid; clear smooth boundary.
Cr—36 inches; tuffaceous rock.

The mean annual soil temperature is 43 to 47 degrees F. Depth to soft bedrock is 20 to 40 inches.

The A horizon has hue of 5YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist or dry. It has 5 to 25 percent gravel, 0 to 10 percent cobbles, and common or many, fine or medium concretions.

The B horizon has hue of 2.5YR or 5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 to 6 when moist or dry. It is clay loam or silty clay loam and has 5 to 25 percent gravel and 0 to 10 percent cobbles.

Molalla Series

The Molalla series consists of deep, well drained soils that formed in colluvium derived from tuff, breccia, and andesite. These soils are on rolling uplands. Slopes are 2 to 30 percent. The mean annual air temperature is about 50 degrees F, and the mean annual precipitation is about 65 inches.

Typical pedon of Molalla cobbly loam, 2 to 8 percent slopes, about 2 miles southeast of the North Fork Dam, in the NW1/4NW1/4SE1/4 of sec. 13, T. 4 S., R. 4 E.

A11—0 to 5 inches; dark reddish brown (5YR 3/2) cobbly loam, dark reddish gray (5YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many fine irregular pores; 15 percent gravel and 15 percent cobbles; medium acid; clear smooth boundary.
A12—5 to 13 inches; dark reddish brown (5YR 3/3) cobbly loam, reddish brown (5YR 4/3) dry; strong

fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; 10 percent gravel and 5 percent cobbles; medium acid; clear smooth boundary.

B1—13 to 18 inches; dark reddish brown (5YR 3/4) clay loam, reddish brown (5YR 4/4)dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; common very fine, fine, and medium roots; many very fine tubular pores; 10 percent gravel; medium acid; clear smooth boundary.

B21—18 to 26 inches; dark reddish brown (5YR 3/4) clay loam, reddish brown (5YR 4/4) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; many very fine tubular pores; 25 percent weathered gravel; strongly acid; clear smooth boundary.

B22—26 to 34 inches; dark reddish brown (5YR 3/3) clay loam, reddish brown (5YR 4/3) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; few very fine, fine, and medium roots; many very fine tubular pores; 10 percent weathered gravel; strongly acid; clear smooth boundary.

B3—34 to 44 inches; dark reddish brown (5YR 3/3) clay loam, reddish brown (5YR 4/3) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine, fine, and medium roots; many very fine tubular pores; 30 percent weathered gravel and 5 percent hard cobbles; strongly acid, clear wavy boundary.

R—44 inches; tuffaceous rock.

The mean annual soil temperature is 50 to 53 degrees F. Depth to bedrock is 40 to 60 inches or more.

The A horizon has value of 2 or 3 when moist and 3 or 4 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon has 0 to 30 percent cobbles and 5 to 20 percent gravel.

The B2 horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 3 or 4 when moist or dry. It is clay loam or silty clay loam and averages 30 to 35 percent clay. The horizon has 5 to 25 percent very soft, weathered gravel and 0 to 15 percent hard cobbles.

Multnomah Series

The Multnomah series consists of deep, well drained soils that formed in gravelly mixed alluvium. These soils are on terraces. Slopes are 0 to 30 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Multnomah silt loam, 0 to 3 percent slopes, in the SE1/4SE1/4SE1/4 of sec. 29, T. 1 S., R. 2 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 4/3) dry; moderate medium and fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; 15 percent gravel; medium acid; clear smooth boundary.

B1—8 to 12 inches; dark brown (10YR 4/3) silt loam, yellowish brown (10YR5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine tubular pores; 15 percent gravel; medium acid; clear smooth boundary.

B2—12 to 26 inches; dark brown (7.5YR4/3) gravelly loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; few thin clay films; 20 percent gravel; medium acid; clear wavy boundary.

C1—26 to 38 inches; dark brown (7.5YR 4/3) gravelly loam, brown (7.5YR 5/4) dry; massive; slightly sticky and slightly plastic; few fine roots; many very fine and fine tubular pores; 25 percent gravel; medium acid; clear smooth boundary.

IIC2—38 to 60 inches; dark grayish brown (10YR 4/2) very gravelly loamy sand, light brownish gray (10YR 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; 50 percent gravel and 20 percent cobbles; medium acid.

The mean annual soil temperature is 54 to 56 degrees F. Thickness of the solum is 20 to 30 inches. Depth to bedrock is more than 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It has 0 to 25 percent gravel and 0 to 5 percent cobbles.

The B horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is loam or silt loam and has 5 to 30 percent gravel.

The IIC horizon is very gravelly or very cobbly sand or loamy sand. It has 35 to 65 percent gravel and 0 to 20 percent cobbles.

Multorpor Series

The Multorpor series consists of deep, excessively drained soils on flood plains. These soils formed in mixed alluvium. Slopes are 0 to 8 percent. The mean annual precipitation is about 90 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Multorpor very cobbly loamy sand, 0 to 8 percent slopes, 1 mile northeast of Wemme, in the NE1/4SE1/4SW1/4 of sec. 30, T. 2 S., R. 7 E.

A1—0 to 5 inches;very dark gray (10YR 3/1) very cobbly loamy sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and common medium roots; many very fine and fine

irregular pores; 30 percent cobbles and 10 percent gravel; very strongly acid; clear smooth boundary.

AC—5 to 13 inches; variegated dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), and very dark grayish brown (10YR 3/2) very cobbly coarse sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; many fine and common medium roots; many very fine and fine irregular pores; 40 percent cobbles, 10 percent stones, and 10 percent gravel; medium acid; gradual wavy boundary.

C—13 to 60 inches; very dark gray (10YR 3/1) extremely stony coarse sand, gray (10YR 5/1) dry; single grain; loose, nonsticky and nonplastic; few fine and medium roots; many very fine and fine irregular pores; 30 percent cobbles, 20 percent stones, and 20 percent gravel; slightly acid.

The mean annual soil temperature is 47 to 50 degrees F. Depth to bedrock is more than 60 inches.

The A horizon has value of 3 when moist and 4 or 5 when dry, and it has chroma of 1 when moist or dry. The horizon has 20 to 30 percent cobbles and 10 to 20 percent gravel.

The AC horizon has value of 3, 4, or 5 when moist and 5, 6, or 7 when dry, and it has chroma of 1 or 2 when moist or dry. The horizon has 30 to 50 percent cobbles, 0 to 30 percent stones, and 10 to 20 percent gravel.

The C horizon has value of 3 or 4 when moist and 3, 4, or 5 when dry, and it has chroma of 1 when moist or dry. The horizon has 25 to 40 percent cobbles, 10 to 30 percent stones, and 10 to 20 percent gravel.

Nekia Series

The Nekia series consists of moderately deep, well drained soils that formed in colluvium derived from basalt. These soils are on rolling uplands. Slopes are 2 to 30 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Nekia silty clay loam, 8 to 15 percent slopes, about 2 miles north of Wilsonville, in the SE1/4SE1/4SE1/4 of sec. 31, T. 2 S., R. 1 E.

Ap—0 to 9 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and common fine roots; many very fine tubular pores; 5 percent gravel; medium acid; clear smooth boundary.

B1—9 to 19 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; many very fine and fine tubular pores; medium acid; gradual smooth boundary.

B21t—19 to 34 inches; dark reddish brown (5YR 3/3) clay, reddish brown (5YR 4/4) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common very fine tubular pores; many moderately thick clay films; medium acid; gradual wavy boundary.

B22t—34 to 39 inches; dark reddish brown (5YR 3/3) gravelly clay, reddish brown (5YR 4/4) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common very fine tubular pores; 25 percent gravel and 5 percent cobbles; medium acid, clear wavy boundary.

R—39 inches; highly weathered basalt.

The mean annual soil temperature is 50 to 56 degrees F. Depth to bedrock is 20 to 40 inches. Basalt boulders are in the profile in some pedons. The upper part of the profile has 0 to 15 percent rock fragments, and the lower part has 0 to 20 percent gravel and 0 to 40 percent cobbles. The weighted average content of rock fragments in the control section is less than 35 percent.

The A horizon has hue of 7.5YR or 5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The Bt horizon has hue of 5YR or 2.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist and 4 to 6 when dry. It is silty clay or clay and has 40 to 50 percent clay.

Newanna Series

The Newanna series consists of moderately deep, well drained soils that formed in colluvium derived from andesite and basalt mixed with volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 90 percent. The mean annual air temperature is about 40 degrees F, and the mean annual precipitation is about 95 inches.

Typical pedon of a Newanna very gravelly loam in an area of Newanna-Thader complex, 30 to 60 percent slopes, about 6 miles southwest of Table Rock, in the NE1/4NW1/4NW1/4 of sec. 6, T. 8 S., R. 5 E.

O2—2 inches to 0; black (10YR 2/1) decomposed organic matter.

A10 to 6 inches; dark brown (7.5YR 3/2) very gravelly loam, brown (7.5YR 5/2) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots and common medium and coarse roots; many fine irregular pores; 30 percent gravel and 10 percent cobbles; strongly acid; clear smooth boundary.

B2—6 to 15 inches; dark brown (7.5YR 3/3) very gravelly loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; many fine irregular pores;

45 percent gravel and 10 percent cobbles; strongly acid; clear smooth boundary.
C—15 to 28 inches; brown (10YR 5/3) extremely cobbly loam, very pale brown (10YR 7/3) dry; massive; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; many very fine tubular pores; 40 percent gravel and 30 percent cobbles; medium acid; abrupt smooth boundary.
R—28 inches; fractured andesite.

The mean annual soil temperature is 40 to 44 degrees F. Where an O horizon is present, the mean summer soil temperature is 47 degrees of less. Depth to fractured bedrock is 20 to 40 inches. The umbric epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It has 25 to 40 percent gravel and 10 to 20 percent cobbles.

The B horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist or dry. It has 20 to 50 percent gravel and 10 to 25 percent cobbles.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 to 4 when moist or dry. It has 20 to 50 percent gravel and 15 to 30 percent cobbles.

Newberg Series

The Newberg series consists of deep, somewhat excessively drained soils on flood plains. These soils formed in mixed alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Newberg fine sandy loam, 2 miles southeast of Carver, along the Clackamas River, in the NE1/4SE1/4NE1/4 of sec. 20, T. 2 S., R. 3 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) fine sandy loam, brown (10YR 4/3) dry; moderate coarse and medium granular structure; soft, very friable, nonsticky and nonplastic; many fine roots; many fine tubular pores; medium acid; clear smooth boundary.
A1—6 to 14 inches; very dark grayish brown (10YR 3/2) fine sandy loam, brown (10YR 4/3) dry; moderate medium and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and medium roots; many fine tubular pores; medium acid; abrupt smooth boundary.
AC—14 to 23 inches; dark yellowish brown (10YR 3/4) fine sandy loam, dark yellowish brown (10YR 4/4) dry; moderate medium and fine subangular blocky structure; loose, nonsticky and nonplastic; many fine roots; many very fine and fine tubular pores; medium acid; abrupt smooth boundary.
C1—23 to 42 inches; dark grayish brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; common fine roots; many fine irregular pores; medium acid; abrupt smooth boundary.
C2—42 to 60 inches; brown (10YR4/3) and dark brown (10YR 3/3) very gravelly sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; many fine irregular pores; 60 percent gravel and 10 percent cobbles; medium acid.

The mean annual soil temperature is 52 to 55 degrees F. Depth to bedrock is more than 60 inches. Very gravelly sand commonly is below a depth of 40 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It is fine sandy loam or loam and has 0 to 10 percent gravel.

The AC horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist or dry. It is fine sandy loam or sandy loam and has 0 to 15 percent gravel.

The C horizon is sand or loamy sand and commonly is stratified.

Powell Series

The Powell series consists of deep, somewhat poorly drained soils that have a hardpan. These soils are on rolling uplands and high terraces. They formed in silty material overlying old, silty alluvium. Slopes are 0 to 30 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Powell silt loam, 0 to 8 percent slopes, about 2 miles east of Happy Valley, in the NW1/4SW1/4SE1/4 of sec. 31, T. 1 S., R. 3 E.

Ap—0 to 7 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; strongly acid; abrupt smooth boundary.
B21—7 to 12 inches; dark brown and dark yellowish brown (10YR 4/3, 4/4) silt loam, brown and light yellowish brown (10YR 5/3, 6/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; common fine tubular pores; strongly acid; abrupt smooth boundary.
B22—12 to 15 inches; dark brown (7.5YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; common faint fine gray and yellow mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots;

common fine tubular pores; very strongly acid; clear wavy boundary.
C1x—15 to 23 inches; dark grayish brown (10YR 4/2) heavy silt loam, strong brown (7.5YR 5/8) dry; light gray (10YR 7/1) tongues; moderate fine and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine roots; few medium irregular pores; thin continuous clay films in pores; few fine black stains; very strongly acid; clear smooth boundary.
C2x—23 to 34 inches; brown (10YR 4/3) and very dark grayish brown (2.5Y 3/2) heavy silt loam, yellowish brown (10YR 5/4) dry; distinct variegated gray, yellow, red, and brown mottles; weak coarse and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine irregular pores; few fine concretions and black stains; thin continuous clay films in pores; medium acid; clear smooth boundary.
C3x—34 to 60 inches; yellowish brown (10YR 5/4) silt loam; variegated gray, yellow, red, and brown mottles; massive; hard, firm, slightly sticky and slightly plastic; few fine irregular pores; thin continuous clay films in channels; medium acid.

The mean annual soil temperature is 54 to 56 degrees F. Thickness of the solum and depth to the hardpan are 15 to 24 inches. Depth to bedrock is more than 60 inches. A perched water table develops over the hardpan in winter.

The A horizon has value of 3 when moist and 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The B horizon has hue of 10YR or 7.5YR, value of 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It has 18 to 27 percent clay.

The Cx horizon is 24 to 48 inches thick. It is silt loam or silty clay loam.

Quatama Series

The Quatama series consists of deep, moderately well drained soils on terraces. These soils formed in stratified glaciolacustrine deposits. Slopes are 0 to 30 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Quatama loam, 3 to 8 percent slopes, about 400 feet south of the quarter corner along the east side of Miley Road, in the NW1/4NW1/4SW1/4 of sec. 19, T. 3 S., R. 1 E.

Ap—0 to 8 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common fine tubular pores; medium acid; abrupt smooth boundary.
B1—8 to 18 inches; dark yellowish brown (10YR 3/4) loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common fine tubular pores; medium acid; clear smooth boundary.
B21t—18 to 27 inches; dark yellowish brown (10YR 3/4) clay loam, light yellowish brown (10YR 6/4) dry; few fine reddish brown (5YR 4/3) mottles; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common fine tubular pores; common moderately thick clay films; common fine black stains; strongly acid; clear smooth boundary.
B22t—27 to 38 inches; dark yellowish brown (10YR 3/4) clay loam, light yellowish brown (10YR 6/4) dry; few fine dark grayish brown (10YR 4/2) mottles; moderate coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common fine tubular pores; common moderately thick clay films; common fine black stains; strongly acid; clear smooth boundary.
C—38 to 60 inches; dark yellowish brown (10YR 3/4) loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, firm, nonsticky and nonplastic; common fine tubular pores; strongly acid.

The mean annual soil temperature is 54 to 56 degrees F. Depth to bedrock is 60 inches or more. Depth to mottles is 15 to 30 inches. Strata of sandy loam to loamy sand are below a depth of 40 inches in some pedons.

The A horizon has chroma of 2 or 3.

The B2t horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 3 or 4 when moist or dry. It is loam or clay loam and averages 25 to 35 percent clay and more than 15 percent sand that is coarser textured than very fine sand.

Ritner Series

The Ritner series consists of moderately deep, well drained soils that formed in colluvium derived from basalt. These soils are on rolling uplands. Slopes are 5 to 60 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Ritner cobbly silty clay loam, 5 to 30 percent slopes, about 5 miles south of Molalla, in the SE1/4NE1/4NE1/4 of sec. 4, T. 6 S., R. 2 E.

O1—2 inches to 0; duff.
A1—0 to 6 inches; dark brown (7.5YR 3/3) cobbly silty clay loam, brown (7.5YR 4/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many fine irregular pores; 20 percent cobbles and 10 percent gravel; medium acid; clear smooth boundary.

B1—6 to 15 inches; brown (7.5YR 4/3) very cobbly silty clay loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many fine and medium roots; many very fine tubular pores; 35 percent cobbles and 10 percent gravel; medium acid; clear smooth boundary.

B2—15 to 26 inches; reddish brown (5YR 4/4) very cobbly silty clay loam, reddish brown (5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common fine and medium roots; many very fine tubular pores; 45 percent cobbles and 10 percent gravel; strongly acid; abrupt smooth boundary.

R—26 inches; fractured bedrock.

The mean annual soil temperature is 51 to 55 degrees F. Depth to bedrock is 20 to 40 inches.

The A horizon has hue of 7.5YR, 5YR, or 10YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 2 to 4 when moist or dry. It has 10 to 20 percent cobbles and 10 to 20 percent gravel.

The B2 horizon has hue of 5YR or 2.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 4 to 6 when moist or dry. It is heavy silty clay loam or silty clay and has 30 to 45 percent cobbles and 10 to 25 percent gravel.

Salem Series

The Salem series consists of deep, well drained soils on stream terraces. These soils formed in alluvium. Slopes are 0 to 12 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 52 degrees F.

Typical pedon of Salem silt loam, 0 to 7 percent slopes, about 5 miles northwest of Estacada, in the SW1/4SE1/4SE1/4 of sec. 36, T. 2 S., R. 3 E.

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many fine irregular pores; slightly acid; clear smooth boundary.

B2t—8 to 14 inches; dark brown (10YR 3/3) gravelly silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores; few thin clay films in pores; 15 percent gravel; slightly acid; clear smooth boundary.

B3t—14 to 24 inches; dark brown (10YR 3/3) gravelly clay loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; few thin clay films in pores; 30 percent gravel; slightly acid; abrupt smooth boundary.

IIC—24 to 60 inches; dark grayish brown (10YR 4/2) very gravelly loamy sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many fine irregular pores; 50 percent gravel and 10 percent cobbles; slightly acid.

The mean annual soil temperature is 53 to 55 degrees F. Depth to the very gravelly IIC horizon is 20 to 36 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It is silt loam or gravelly silt loam and has 0 to 30 percent rock fragments.

The B2t horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It is silty clay loam, clay loam, or silt loam and has 10 to 35 percent gravel. The horizon has few to common, thin or moderately thick clay films.

The B3t horizon has value of 3 or 4 when moist and 4 to 6 when dry, and it has chroma of 3 or 4 when moist or dry. It is gravelly loam or gravelly clay loam and has 20 to 50 percent gravel.

The IIC horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 2 to 4 when moist or dry. It has 35 to 60 percent gravel and 0 to 10 percent cobbles.

Saum Series

The Saum series consists of deep, well drained soils that formed in mixed silty material and colluvium derived from basalt. These soils are on rolling uplands. Slopes are 3 to 60 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Saum silt loam, 8 to 15 percent slopes, about 3 miles west of Wilsonville, in the SW1/4SW1/4NW1/4 of sec. 17, T. 3 S., R. 1 W.

A11—0 to 8 inches; dark brown (7.5YR 3/2)silt loam, brown (7.5YR 5/2) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots; many very fine irregular pores; 5 percent fine concretions; medium acid; clear smooth boundary.

A12—8 to 15 inches; dark brown (7.5YR 3/3) silty clay loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and plastic; many very fine and fine roots; many fine tubular pores; 5 percent fine concretions; medium acid; clear smooth boundary.

B2—15 to 26 inches; dark reddish brown (5YR 3/4) silty clay loam, reddish brown (5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm,

slightly sticky and plastic; many fine and common medium roots; many very fine tubular pores; few thin clay films; 5 percent gravel; medium acid; clear smooth boundary.

IIB3—26 to 35 inches; reddish brown (5YR 4/4) gravelly silty clay loam, yellowish red (5YR 5/6) dry; moderate medium and fine subangular blocky structure; hard, firm, slightly sticky and plastic; many fine and common medium roots; many very fine tubular pores; few thin clay films; 15 percent gravel, 10 percent stones, and 5 percent cobbles; few black stains; medium acid; clear smooth boundary.

IIC—35 to 50 inches; yellowish red (5YR 4/6) gravelly silty clay loam, yellowish red (5YR 5/6) dry; massive; hard, firm, slightly sticky and plastic; many very fine tubular pores; few thick clay films on rock fragments; 15 percent gravel, 10 percent stones, and 5 percent cobbles; medium acid, clear wavy boundary.

IIR—50 inches; basalt.

The mean annual soil temperature is 53 to 56 degrees F. Depth to bedrock is 40 to 60 inches or more. The control section is 20 to 35 percent rock fragments.

The A horizon has hue of 7.5YR or 5YR, value of 3 when moist and 5 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry. It has 0 to 5 percent gravel.

The B2 horizon has value of 3 or 4 when moist and 5 when dry, and it has chroma of 4 to 6 when moist or dry. It has 0 to 10 percent gravel.

The IIB and IIC horizons have hue of 5YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. They are silty clay loam, silty clay, or gravelly silty clay loam. The horizons have 15 to 30 percent gravel, 5 to 20 percent cobbles, and 5 to 20 percent stones.

Sawtell Series

The Sawtell series consists of deep, moderately well drained soils that formed in gravelly old alluvium. These soils are on terraces. Slopes are 0 to 15 percent. The mean annual air temperature is about 52 degrees F, and the mean annual precipitation is about 50 inches.

Typical pedon of Sawtell silt loam, 0 to 8 percent slopes, about 1 mile southwest of Molalla, in the NW1/4SE1/4NE1/4 of sec. 18, T. 5 S., R. 2 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; many very fine tubular pores; 5 percent gravel; strongly acid; clear smooth boundary.

A1—6 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; many very fine tubular pores; 5 percent gravel; strongly acid; clear smooth boundary.

B21—13 to 20 inches; dark brown (10YR 3/3) gravelly clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine, fine, and medium roots; many very fine tubular pores; 20 percent gravel and 5 percent cobbles; common coarse manganese concretions; strongly acid; clear smooth boundary.

IIB22t—20 to 31 inches; brown (10YR 4/3) very gravelly clay loam, yellowish brown (10YR 5/4) dry; few medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; hard, friable, sticky and plastic; few very fine, fine, and medium roots; many very fine tubular pores; common moderately thick dark yellowish brown (10YR 4/4) clay films; 30 percent partially weathered rounded gravel and 10 percent cobbles; many coarse manganese concretions; strongly acid; gradual smooth boundary.

IIB23t—31 to 43 inches; brown (10YR 4/3) very gravelly clay loam, light yellowish brown (10YR 6/4) dry; common fine and medium distinct strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic;few very fine and fine roots; common very fine tubular pores; common moderately thick dark yellowish brown (10YR 4/4) clay films; 50 percent gravel and 10 percent cobbles; strongly acid; clear smooth boundary.

IIC—43 to 60 inches; yellowish brown (10YR 5/4) very gravelly clay, light yellowish brown (10YR 6/4) dry; many coarse distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/8) mottles; massive; very hard, very firm, very sticky and very plastic; common very fine tubular pores; 40 percent gravel and 15 percent cobbles; strongly acid.

The mean annual soil temperature is 52 to 54 degrees F. Depth to the IIB horizon is 15 to 25 inches. Depth to bedrock is 60 inches or more. The mollic epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It has 0 to 15 percent gravel.

The IIB2t horizon has hue of 10YR or 7.5YR, value of 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. Mottles that have chroma of 2 or less are below a depth of 30 inches. The IIB2t horizon is clay loam or loam and has 30 to 50 percent gravel and 5 or 20 percent cobbles.

The IIC horizon has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 to 5 when moist or dry. It is clay, clay loam, or loam and

has 30 to 60 percent gravel and 5 to 25 percent cobbles.

Soosap Series

The Soosap series consists of moderately deep, well drained soils that formed in colluvium derived from tuff, breccia, and andesite mixed with volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 30 percent. The mean annual air temperature is about 42 degrees F, and the mean annual precipitation is about 85 inches.

Typical pedon of a Soosap gravelly loam in an area of Highcamp-Soosap complex, 5 to 30 percent slopes, about 2.5 miles west of Cougar Lake, in the NE1/2SE1/4NW1/4 of sec. 15, T. 6 S., R. 4 E.

O1—1 inch to 0; partially decomposed needles, leaves, and twigs.

A11—0 to 6 inches; very dark brown (10YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, fine, and medium roots; many fine irregular pores; 15 percent gravel; very strongly acid; clear smooth boundary.

A12—6 to 13 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, fine, and medium roots; many fine irregular pores; 10 percent gravel; strongly acid; clear smooth boundary.

B21—13 to 21 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 4/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine and fine roots; many very fine tubular pores; 10 percent gravel; strongly acid; clear smooth boundary.

B22—21 to 35 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 4/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; common very fine and fine roots; many very fine tubular pores; 10 percent gravel; strongly acid; clear smooth boundary.

Cr—35 to 44 inches; very soft, weathered tuff.

R—44 inches; unweathered tuff.

The mean annual soil temperature is 42 to 46 degrees F. The mean summer soil temperature is less than 47 degrees in areas that have an O horizon and are in full shade. Depth to bedrock is 20 to 40 inches. The control section is 10 to 35 percent rock fragments.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 1 to 3 when moist or dry. It is loam or silt loam and has 0 to 30 percent gravel and 0 to 20 percent cobbles.

The B2 horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is loam, silt loam, or clay loam. The horizon has as much as 35 percent rock fragments, of which 0 to 30 percent is cobbles and 10 to 20 percent is gravel.

The Cr horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry.

Springwater Series

The Springwater series consists of moderately deep, well drained soils that formed in colluvium derived from sandstone. These soils are on rolling uplands. Slopes are 3 to 60 percent. The mean annual precipitation is about 55 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Springwater loam, 30 to 60 percent slopes, about 1 mile west of Wilhoit, in the SW1/4NE1/4NE1/4 of sec. 17, T. 6 S., R. 2 E.

O1—2 inches to 0; partially decomposed needles, leaves, and twigs.

A11—0 to 7 inches; dark brown (7.5YR 3/2) loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many fine irregular pores; medium acid; clear smooth boundary.

A12—7 to 15 inches; dark brown (7.5YR 3/3) clay loam, pale brown (10YR 6/3) dry; strong medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine, medium, and coarse roots; many very fine tubular pores; medium acid; clear smooth boundary.

B21—15 to 21 inches; brown (7.5YR 4/4) clay loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and plastic; common fine and medium roots; many very fine tubular pores; medium acid; gradual smooth boundary.

B22—21 to 27 inches; brown (7.5YR 4/4) clay loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; very hard, very firm, sticky and plastic; few very fine roots; many very fine tubular pores; 10 percent weathered sandstone gravel; medium acid; clear smooth boundary.

B3—27 to 37 inches; brown (7.5YR 4/4) gravelly clay loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; very hard, very firm, sticky and plastic; many very fine tubular pores; few thin reddish brown (5YR 4/4) clay films; 30

percent weathered sandstone gravel; medium acid; abrupt smooth boundary.
R—37 inches; fractured sandstone.

The mean annual soil temperature is 50 to 52 degrees F. Depth to fractured sandstone is 20 to 40 inches.

The A horizon has hue of 7.5YR or 10YR, value of 2 to 4 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. It is loam or clay loam and has 0 to 10 percent gravel.

The B2 horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 6 when dry, and chroma of 3 or 4 when moist or dry. It is clay loam or loam and has 0 to 25 percent gravel.

The B3 horizon has hue of 7.5YR, 10YR, or 5YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. It is clay loam or loam and has 20 to 40 percent sandstone gravel.

Talapus Series

The Talapus series consists of deep, well drained soils that formed in colluvium mixed with glacial till and volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 60 percent. The mean annual precipitation is about 90 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of a Talapus very gravelly loam in an area of Talapus-Lastance complex, 5 to 30 percent slopes, about 3 miles southeast of Goat Mountain, in the SW1/4NW1/4SW1/4 of sec. 36, T. 5 S., R. 4 E.

O1—2 inches to 0; duff.
A11—0 to 11 inches; very dark brown (10YR 2/2) very gravelly loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; many fine irregular pores; 40 percent small gravel and 10 percent cobbles; strongly acid; gradual smooth boundary.
A12—11 to 17 inches; very dark brown (10YR 2/2) very gravelly loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine tubular pores; 30 percent gravel and 15 percent cobbles; strongly acid; clear smooth boundary.
B1—17 to 28 inches; dark brown (10YR 3/3) extremely gravelly loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; many very fine tubular pores; 45 percent gravel and 20 percent cobbles; strongly acid; clear smooth boundary.
B2—28 to 43 inches; brown (10YR 4/3) extremely gravelly loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; many very fine tubular pores; 50 percent gravel and 15 percent cobbles; very strongly acid; clear smooth boundary.
IIC—43 to 60 inches; brown (10YR 4/3) extremely gravelly loam, pale brown (10YR 6/3) dry; massive; hard, firm, slightly sticky and slightly plastic; slightly brittle; few very fine tubular pores; 60 percent gravel and 20 percent cobbles; very strongly acid.

The mean annual soil temperature is 40 to 44 degrees F. The mean summer soil temperature is 47 degrees or less in areas where an O horizon is present. Depth to bedrock is more than 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 1 or 2 when moist and 1 to 3 when dry. It has 30 to 45 percent gravel and 5 to 15 percent cobbles.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist or dry. It is loam or silt loam and has 45 to 70 percent gravel and 5 to 15 percent cobbles.

The IIC horizon has hue of 10YR or 7.5YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist or dry. It is loam or silt loam and has 50 to 70 percent gravel and 10 to 20 percent cobbles.

Thader Series

The Thader series consists of moderately deep, well drained soils that formed in colluvium derived from andesite and basalt mixed with volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 90 percent. The mean annual precipitation is about 95 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of a Thader very cobbly loam in an area of Newanna-Thader complex, 30 to 60 percent slopes, about 2 miles southeast of Cougar Lake, in the NE1/4NE1/4SW1/4 of sec. 30, T. 6 S., R. 5 E.

O2—2 inches to 0; black (10YR 2/1) decomposing organic matter.
A2—0 to 2 inches; dark gray (10YR 4/1) very cobbly loam, gray (10YR 6/1) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many fine irregular pores; 40 percent cobbles and 20 percent gravel; very strongly acid; abrupt smooth boundary.
B21ir—2 to 4 inches; dark reddish brown (5YR 3/2) very cobbly loam, dark brown (7.5YR 4/4) dry; massive; hard, firm, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine irregular pores; 40 percent cobbles and 20 percent gravel; strongly acid; clear smooth boundary.
B22ir—4 to 11 inches; dark brown (7.5YR 3/3) very cobbly loam, brown (7.5YR 4/4) dry; weak medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine,

fine, and medium roots; many very fine tubular pores; 30 percent cobbles and 25 percent gravel; strongly acid; clear smooth boundary.
B3—11 to 23 inches; brown (7.5YR 4/4) very cobbly loam, light brown (7.5YR 6/4) dry; massive; slightly hard, firm, slightly sticky and slightly plastic; few very fine, fine, and medium roots; many very fine tubular pores; 40 percent gravel and 30 percent cobbles; strongly acid; abrupt wavy boundary.
R—23 inches; fractured bedrock.

The mean annual soil temperature is 40 to 44 degrees F, and the mean summer soil temperature is 47 degrees or less in areas where an O horizon is present. Depth to bedrock is 20 to 40 inches.

The A2 horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 1 or less when moist or dry. The horizon has 20 to 50 percent cobbles and 5 to 25 percent gravel.

The B2 horizon has hue of 5YR in the upper part and 7.5YR or 5YR in the lower part. The horizon has value of 3 or 4 when moist and 4 to 6 when dry, and it has chroma of 2 to 4 when moist or dry. It is loam or silt loam and has 25 to 50 percent cobbles and 15 to 40 percent gravel.

Wapato Series

The Wapato series consists of deep, poorly drained soils that formed in mixed alluvium. These soils are on flood plains. Slopes are 0 to 3 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Wapato silty clay loam, about 2 miles west of Molalla, in the SE1/4NE1/4NW1/4 of sec. 13, T. 5 S., R. 1 E.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many fine irregular pores; slightly acid; clear smooth boundary.
A1—8 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; common fine distinct dark reddish gray (5YR 4/2) mottles; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common very fine, fine, and medium roots; many very fine tubular pores; medium acid; clear smooth boundary.
B21g—18 to 27 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; many fine distinct reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; many very fine tubular pores; medium acid; clear smooth boundary.
B22g—27 to 45 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; many fine distinct reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine tubular pores; medium acid; clear smooth boundary.
B3g—45 to 60 inches; grayish brown (10YR 5/2) silty clay, light brownish gray (10YR 6/2) dry; many coarse distinct yellowish red (5YR 4/6) mottles; massive; hard, very firm, very sticky and plastic; common very fine tubular pores; medium acid.

The mean annual soil temperature is 53 to 55 degrees F. Unless these soils are artificially drained, they are saturated with water in winter. The mollic epipedon is 10 to 24 inches thick. Depth to bedrock is more than 60 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It is silty clay loam or silt loam.

The B2g horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 1 or 2 when moist or dry. It is silty clay loam or silty clay.

The B3g horizon has hue of 10YR to 5Y, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. It is silty clay or silty clay loam.

Wilhoit Series

The Wilhoit series consists of deep, well drained soils that formed in colluvium derived from andesite, breccia, and tuff mixed with volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 60 percent. The mean annual precipitation is about 80 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of a Wilhoit gravelly loam in an area of Wilhoit-Zygore complex, 5 to 30 percent slopes, about 0.5 mile southeast of the Bee Ranch, in the NW1/4NE1/4NE1/4 of sec. 23, T. 7 S., R. 3 E.

O1—1 inch to 0; partially decomposed needles, leaves, and twigs.
A11—0 to 4 inches; very dark grayish brown (10YR 3/2) gravelly loam, dark grayish brown (10YR 4/2) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, fine, and medium roots and few coarse roots; many fine irregular pores; 15 percent gravel; medium acid; clear smooth boundary.
A12—4 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, fine, and medium roots and few coarse roots; many fine irregular pores; 5 percent gravel; strongly acid; clear smooth boundary.

B1—15 to 33 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; common medium and coarse roots and few fine roots; many very fine tubular pores; 10 percent gravel; strongly acid; gradual smooth boundary.
B2—33 to 43 inches; dark brown (10YR 4/3) clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and slightly plastic; slightly smeary; few very fine and fine roots; many very fine tubular pores; 10 percent gravel; strongly acid; gradual smooth boundary.
B3—43 to 52 inches; dark brown (7.5YR 4/4) gravelly loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; slightly smeary; few very fine and fine roots; many very fine tubular pores; 25 percent gravel; strongly acid; gradual wavy boundary.
Cr—52 inches; soft, weathered tuff.

The mean annual soil temperature is 43 to 47 degrees F. Depth to soft bedrock is 40 to 60 inches or more.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 2 or 3 when moist or dry. It has 5 to 30 percent gravel and 0 to 15 percent cobbles.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is loam or clay loam. The horizon has as much as 35 percent rock fragments, of which 5 to 30 percent is gravel and 0 to 20 percent is cobbles.

Willamette Series

The Willamette series consists of deep, well drained soils on broad terraces. These soils formed in stratified glaciolacustrine deposits. Slopes are 0 to 20 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Willamette silt loam, 0 to 3 percent slopes, 1.5 miles south of Wilsonville, in the NW1/4NW1/4NW1/4 of sec. 36, T. 3 S., R. 1 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; few reddish brown and black concretions; slightly acid; clear smooth boundary.
A1—6 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; common fine reddish brown and black concretions; slightly acid; clear smooth boundary.
A3—14 to 20 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; common medium reddish brown and black concretions; slightly acid; clear smooth boundary.
B1t—20 to 26 inches; dark brown (10YR 3/3) silt loam, dark brown (10YR 4/3) dry; moderate medium subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; few thin clay films; common medium reddish brown and black concretions; few black stains; slightly acid; gradual smooth boundary.
B2t—26 to 41 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure; hard, friable, sticky and plastic; common fine roots; common very fine tubular pores; many moderately thick clay films; few reddish brown and black concretions; slightly acid; clear smooth boundary.
B3t—41 to 58 inches; dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; moderate coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; common very fine tubular pores; common moderately thick clay films; few reddish brown and black concretions; slightly acid; gradual smooth boundary.
C—58 to 65 inches; dark yellowish brown (10YR 4/4) silt loam, brown (10YR 5/3) dry; common fine distinct strong brown (7.5YR 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; neutral.

The mean annual soil temperature is 53 to 55 degrees F. The profile is more than 60 inches thick. The solum is 40 to 60 inches thick or more. The mollic epipedon is 20 to 30 inches thick.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The Bt horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. In some pedons the horizon is mottled below a depth of 30 inches. The horizon is silty clay loam or heavy silt loam.

The C horizon is mainly silt loam or silty clay loam. In some pedons it is very gravelly loam below a depth of 35 inches.

Witzel Series

The Witzel series consists of shallow, well drained soils that formed in cobbly colluvium derived from basalt. These soils are on rolling uplands. Slopes are 3 to 75

percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Witzel very stony silt loam, 3 to 40 percent slopes; about 1 mile northeast of the Canby Ferry, on Petes Mountain; in the SW1/4NW1/4SW1/4 of sec. 15, T. 3 S., R. 1 E.

A1—0 to 4 inches; very dark brown (10YR 2/2) very stony silt loam, dark brown (10YR 4/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine irregular pores; 25 percent cobbles and 15 percent stones; slightly acid; clear smooth boundary.

B2—4 to 16 inches; dark brown (7.5YR 3/2) very stony silty clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, firm, sticky and plastic; common fine and medium roots; many very fine tubular pores; 30 percent stones and 30 percent cobbles; medium acid; abrupt wavy boundary.

R—16 inches; fractured basalt.

The mean annual soil temperature is 51 to 55 degrees F. Thickness of the solum and depth to bedrock are 12 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It has 15 to 35 percent stones and 0 to 25 percent cobbles.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It is very cobbly silty clay loam, very cobbly clay loam, or very gravelly clay loam and has 35 to 60 percent cobbles and 0 to 30 percent gravel.

In some areas the R horizon has tongues of soil material in the fractures.

Woodburn Series

The Woodburn series consists of deep, moderately well drained soils that formed in stratified glaciolacustrine deposits. These soils are on broad terraces. Slopes are 0 to 20 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 53 degrees F.

Typical pedon of Woodburn silt loam, 3 to 7 percent slopes, about 6 miles west of Mollala, in the NE1/4SE1/4SW1/4 of sec. 8, T. 5 S., R. 1 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine and fine tubular pores; common fine reddish brown concretions; medium acid; abrupt smooth boundary.

A1—7 to 16 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; few reddish brown concretions; slightly acid; clear smooth boundary.

B21t—16 to 26 inches; dark yellowish brown (10YR 3/4) silty clay loam, brown (7.5YR 5/4) dry; moderate coarse and medium subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many very fine tubular pores; few thin clay films; few reddish brown concretions; few black stains; medium acid; clear smooth boundary.

B22t—26 to 38 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; few medium distinct dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; hard, friable, sticky and plastic; slightly brittle; common fine roots; many very fine tubular pores; many moderately thick clay films; medium acid; clear smooth boundary.

B3t—38 to 54 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; common fine distinct dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; very hard, very firm, slightly sticky and slightly plastic; brittle; few very fine roots; many very fine tubular pores; common moderately thick clay films; few fine black concretions; medium acid; gradual smooth boundary.

C—54 to 68 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; massive; very hard, very firm, slightly sticky and slightly plastic; brittle; many very fine tubular pores; few moderately thick clay films in pores; few black stains; medium acid.

The mean annual soil temperature is 53 to 55 degrees F. Depth to bedrock is 60 inches or more. The solum is 40 to 60 inches thick or more. Distinct mottles that have chroma of 2 are at a depth of less than 30 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The Bt horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is silty clay loam or silt loam. The lower part of the Bt horizon is slightly brittle to brittle.

Zygore Series

The Zygore series consists of deep, well drained soils that formed in colluvium derived from andesite and basalt mixed with volcanic ash. These soils are on mountainous uplands. Slopes are 5 to 90 percent. The mean annual precipitation is about 80 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Zygore gravelly loam, 5 to 30 percent slopes, about 2 miles south of Alder Creek, in the SE1/4SE1/4SW1/4 of sec. 33, T. 2 S., R. 6 E.

O1—3 inches to 0; partially decomposed litter.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) gravelly loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; many fine irregular pores; 30 percent gravel; medium acid; clear smooth boundary.

A3—5 to 11 inches; very dark grayish brown (10YR 3/2) gravelly loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, medium, and coarse roots; many very fine tubular pores; 20 percent gravel and 10 percent cobbles; medium acid; clear wavy boundary.

B21—11 to 24 inches; dark brown (10YR 4/3) very cobbly loam, brown (10YR 5/3) dry; moderate medium subangular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; 25 percent cobbles and 15 percent gravel; medium acid; gradual wavy boundary.

B22—24 to 40 inches; dark brown (10YR 4/3) very cobbly loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; many very fine tubular pores; 35 percent cobbles and 10 percent gravel; medium acid; clear smooth boundary.

C—40 to 60 inches; variegated dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) very cobbly loam, pale brown (10YR 6/3) dry; massive; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; many very fine tubular pores; 40 percent cobbles and 10 percent gravel; medium acid.

The mean annual soil temperature is 43 to 47 degrees F. Depth to bedrock is more than 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It has 10 to 20 percent gravel and 10 to 20 percent cobbles.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is cobbly or very cobbly loam or silt loam and has 20 to 30 percent cobbles, 10 to 30 percent gravel, and 0 to 5 percent stones.

The C horizon has hue of 10YR or 7.5YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 3 to 6 when moist or dry. It has 10 to 30 percent gravel, 20 to 40 percent cobbles, and 0 to 5 percent stones.

Formation of the Soils

Soil is a natural, three-dimensional body on the earth's surface. Its characteristics and properties have been determined by physical and chemical processes that result from the interaction of the five factors of soil formation—climate, living organisms, time, topography, and parent material (*7, 16, 19*). The influence of any one of these factors varies from place to place, but the interaction of all the factors determines the kind of soil that forms.

The soils in this survey area have been greatly influenced by such factors as the very cold, wet, short growing season high in the Cascade Range and the warm, dry, long growing season at the lower elevations along the Willamette River. The age and type of parent material have greatly influenced soil development in areas of recent alluvium along the flood plains of the Willamette River and in areas of old alluvium on terraces. In higher areas of the eastern part of the survey area, colluvium and glacial till derived from andesite and basalt and mixed with volcanic ash have imparted special characteristics to the soils.

In this section the soil-forming factors of climate and living organisms are discussed separately. The factors of time, topography, and parent material are discussed together under the heading "Geomorphic Surfaces and Soil Development."

Climate

Climate has a strong influence on soil formation. Temperature and moisture greatly influence the kind of vegetation that grows and the rate at which organic matter decomposes and minerals weather. Temperature and moisture also influence the rate of removal of material from some soil horizons and the rate of accumulation in others.

In this survey area there are four major climatic areas that greatly influence soil genesis. These are areas characterized by (1) warm, dry, summers and cool, moist winters; (2) warm, moist summers and cool, moist winters; (3) warm, moist summers and cold, moist winters; and (4) cool, moist summers and cold, moist winters. In the western part of the survey area the summers are warm and dry and the winters are cool and moist, giving rise to soils with a xeric moisture regime (*29*). The growing season is long, with plant growth beginning early in spring and continuing through midsummer. On the younger surfaces the accumulation of organic matter and the limited leaching of bases have produced Mollisols such as Cloquato, Chehalis, McBee, and Newberg soils. On the older surfaces, where the soil-forming factors have been active for long periods of time, Argixerolls such as Willamette and Woodburn soils and Haploxeralfs such as Latourell and Quatama soils have formed. In areas where accumulation of organic matter has been slower or where man has removed parts of the epipedon, Inceptisols such as Aloha and Powell soils are present. On the oldest surfaces Ultisols such as Jory and Nekia soils have developed.

Summers are warm and moist and winters are cool and moist near the western slopes of the Cascade Range, giving rise to soils with a udic moisture regime. Most of this climatic zone is represented by the older surfaces, where Udults such as Cazadero and Alspaugh soils have developed. Plant growth begins late in spring and continues until late in summer or early in fall. On the younger surfaces the accumulation of organic matter and the rapid leaching of bases have given rise to the development of Andepts and Umbrepts such as Bull Run, Aschoff, and Kinney soils.

In the eastern part of the survey area, on the western slopes of the Cascade Range, summers are warm and moist and winters are cold and moist. The growing season is short, and plant growth and the kinds of plants in the climax community are limited. This area is within the Western Cascade physiographic province of Oregon, described by Franklin and Dyrness (*28*). The soils are developing under a plant community that is within the western hemlock zone. This environment generally produces enough plant growth for the development of an umbric epipedon. Leaching has been such that base saturation is not excessively low, and frigid Haplumbrepts such as Fernwood, Wilhoit, and Zygore soils have developed.

At elevations higher than 2, 800 feet, the summers are cool and moist and the winters are cold and moist. Snow covers the surface during much of the winter and early in spring, and the growing season is very short. Generally, sufficient vegetation is produced to allow development of an umbric epipedon. Soils common to these areas are Cryumbrepts such as Kinzel and Soosap soils. Where insufficient organic matter has accumulated to produce an umbric epipedon, an ochric epipedon has developed, such as in the Highcamp and Divers soils (Cryochrepts). Where the annual precipitation exceeds 100 inches, the

soil development strongly reflects the kind of material in which the soils formed. Acid leaching of coarse textured silicious material has produced albic horizons that are extremely acid. Illuviated iron and organic carbon have formed spodic horizons, producing Cryorthods such as the Lastance and Thader soils.

Living organisms, especially the higher plants, are an active factor in soil formation. The kinds of changes they bring about depend mainly on the life processes peculiar to each kind of organism. The kinds of organisms that live on and in the soil are determined in turn by climate and by the parent material, topography, and age of the soil.

Plants provide a cover that reduces erosion and stabilizes the soil surface. Leaves, twigs, roots, and remains of entire plants accumulate on the surface of forested soils and are decomposed by micro-organisms, earthworms, and other soil fauna. Plant roots widen cracks in the underlying rock, permitting water to penetrate. The uprooting of trees by wind also mixes soil layers and loosens the underlying material.

In Clackamas County the soils formed under three major types of plant cover. In the xeric soil zone grass is a prominent member of the plant community, along with a mixed conifer and deciduous forest of Oregon white oak, bigleaf maple, and Douglas-fir. The annual dieback of roots provides large amounts of organic material. The grass takes up calcium and other bases and returns them to the soil annually, which reduces the effects of leaching. Mollisols such as Willamette and Woodburn soils developed under these conditions. In the udic soil zone the proportion of conifers is greater. Organic matter has accumulated in the soils; however, bases have been taken up by the conifers and have not so readily been returned to the soil. The greater precipitation in the udic soil zone has resulted in more leaching of bases, so that soils with an umbric epipedon such as Cazadero, Kinney, and McCully soils have formed. At the higher elevations, primarily in places in the Cascade Range where precipitation exceeds 100 inches annually, the plant communities contain primarily conifers such as western hemlock and noble fir. In these areas the presence of a large amount of organic matter and the leaching of bases have produced a high concentration of hydrogen ion in the soils. This has resulted in the mobilization of iron and alluminum and in the formation of Typic Cryorthods such as the Lastance and Thader soils.

Small animals, earthworms, insects, and micro-organisms influence the formation of soils in several ways. They mix organic matter into the mineral soil material and accelerate the decomposition of organic matter by breaking down the remains of plants. Small animals burrow into the soil and mix the layers. Earthworms and other small invertebrates feed on the organic matter in the upper few inches of soil material. They slowly but continually mix the soil material and can alter its chemistry. Bacteria, fungi, and other micro-organisms hasten the weathering of rocks and the decomposition of organic matter.

In this survey area, conditions generally are favorable for most organisms to function. Earthworms are very common in all areas except in the frigid and cryic soil zones. Small animals such as gophers and moles are common in the lower, warmer areas.

Geomorphic Surfaces and Soil Development

By Dr. R. B. Parsons, research soil scientist, Soil Conservation Service.

Geomorphic surfaces were mapped on high-altitude aerial photographs for the Willamette Valley, including the western part of the survey area. The surfaces were visually traced throughout the survey area. Sequential relations among surfaces, stereoscopic observations, and elevation, as well as photo interpretation of tonal patterns, were used to map the surfaces. Each geomorphic surface is named for a locality where that specific surface is well expressed (*7, 18*).

The geomorphic surfaces fit a time sequence, but there are exceptions that are noted in the discussion of individual surfaces. Following is a list of the geomorphic surfaces in chronological order, beginning with the youngest: Horseshoe; Ingram; Luckiamute; Winkle; Champoeg; Senecal; Calapooyia; Bethel; Dolph; Eola.

Steep, broken topography that has some slopes of more than 100 percent characterize the Looney unit. Because of variable stability of the landscape, the soils and surfaces of the Looney unit fit no particular span of time.

Horseshoe surface—The Horseshoe surface is the lower of the two flood plains in the area. The Horseshoe surface has low relief and includes the stream channel and associated features such as point bar deposits, channel fillings, and abandoned meanders. The surface generally is underlain by coarse textured or moderately coarse textured alluvium. Many areas of the Horseshoe surface are not vegetated, but some areas support young stands of willows or cottonwoods. In this area elevation is dominantly 30 to 300 feet. Annual flooding inundates the Horseshoe surface. Rapid changes in the Horseshoe landscape result from cutting of new channels, abandonment of older channels, lateral migration of meanders, and downstream movement of alluvial deposits. In some third order valleys there are not two identifiable flood plains (Horseshoe and Ingram), which attests to the recent age of the surface. The Horseshoe surface began to form only a short time ago, as shown by the presence of metallic artifacts in the alluvium; therefore, a post-settlement age, since the middle of the 19th century, is reasonable.

The Horseshoe surface is characterized by Fluventic Haploxerolls, Camas soils, and Riverwash. Camas soils,

which formed on dynamic surfaces such as flood plains, consist of unweathered gravelly or cobbly sediment. They exhibit little evidence of soil development. Camas soils have an A horizon with weak subangular blocky structure. These soils are so young that they have no diagnostic horizons other than a mollic epipedon and a presumed irregular decrease in organic matter content as depth increases, which has been inherited from the alluvial parent material.

Ingram surface.—The Ingram surface is the higher of the two flood plains in the area. The topography of the Ingram surface is typically undulating. As much as 10 feet of relief is produced by overbank channeling at flood stage. The bars and channels have an approximate orientation parallel to the screen. In some valleys the bars seldom, if ever, are flooded. The expression of microrelief on the surface is related to the competence of the stream that flowed through the area. Longitudinal stream profiles with segmented gradients also add to the complexity of the Ingram surface as a flood plain. Elevations are generally between 40 and 300 feet, but they are as high as 1,200 feet in the vicinity of Zigzag. The texture of the soils generally is gravelly sandy loam, silt loam, or silty clay loam, although some sandy strata are common.

Radiocarbon dating assigns ages for the sediment associated with the Ingram surface as 550 to 3,290 years old; therefore, the change in the stream system that caused abandonment of the Winkle surface as a flood plain occurred 3,290 to 5,250 years ago, as the latter date is the earliest established for the Winkle surface. The partial abandonment of the Ingram surface as a flood plain occurred less than 550 years ago, which indicates the dynamic nature of the soil landscape.

Soils that formed in the alluvial sediment of the Ingram surface include Cumulic Ultic Haploxerolls, such as Chehalis, Cloquato, and McBee soils; Fluvaquentic and Vertic Haplaquolls, such as Wapato and Cove soils; and Typic Udorthents, such as Multorpor soils. Chehalis, Cloquato, and McBee soils have a mollic epipedon, presumably inherited from the alluvial parent material, that has an irregular decrease in organic matter content with depth. This is partly from periodic burial of the soil surface and partly from organic matter carried with the sediment as it is deposited. These soils have moderate to strong structure and have been in place long enough to exhibit a cambic B horizon. Wapato and Cove soils, in addition to a mollic epipedon and moderate prismatic or blocky structure in the cambic horizon, show the mobility of ferrous iron to form distinct mottles.

Multorpor and Dabney soils show little development other than the accumulation of organic matter in the surface layer. Dabney soils are no longer subject to flooding because of the rapid entrenchment of the Horseshoe surface. The Ingram surface on the lower reaches of the Sandy River is then a low terrace. Among the other soils on this surface are the soils of the Newberg series.

Luckiamute surface—This surface is on flood plains of small drainageways that contain local alluvium derived from the erosion of material associated with the Bethel, Dolph, Eola, and Looney surfaces. As defined, the concept of the Luckiamute surface includes areas of Horseshoe, Ingram, and Winkle surfaces that are too small to separate at the scale used in mapping.

The topography of the Luckiamute surface is typical of that of flood plains of small streams. Relief is absent except for minor corrugations produced by channeling. A few small alluvial fans that extend out of small valleys are included with the Luckiamute surface and contain sediment composed of material eroded in the immediate source area. As the Luckiamute surface can be directly traced to the Horseshoe and Ingram surfaces, it is assumed that the age of the surface brackets the age of the latter two surfaces where they occur in the larger valleys.

The soils of the Luckiamute surface are dominantly of the Wapato and Cove series, which are included in the description of the Horseshoe and Ingram surfaces. Borges and Delena soils are in swales and drainageways cut into the Bethel and Dolph surfaces. These soils have formed in valley side alluvium (*31*) derived from Portland Hills Silt and clayey relict Paleosols upslope.

Winkle surface—The middle to early Holocene Winkle surface is the oldest surface related to the present drainage systems of western Oregon. Most of the Winkle surface has the morphology typical of abandoned flood plains of aggrading streams. In this area, particularly along the Clackamas River, the bars and channels exhibit considerably greater relief than, for instance, those along the Molalla River and its major tributaries. The difference in elevation between bar and channel is due largely to the competence of the stream, so one could expect the Clackamas River to have the better expression of this geomorphic feature. The braided, overloaded stream channel that deposited sediment associated with the Winkle surface reflects the size of the stream responsible for the formation of the bars and channels. The elevation of the Winkle surface in this area generally is 75 to 500 feet, but along the Sandy River Winkle in the vicinity of Zigzag it is as much as 1,200 feet. The sediment is dominated by silt and clay and commonly is underlain by stratified sand and gravel at a depth of 4 to 6 feet.

A few areas of the Winkle surface are Humaquepts, ponded, on old lakebeds and in abandoned channels with low relief (*17*). Carbon 14 dating of sediment beneath the Winkle surface yields a minimum age of 5,250 years and a maximum of 12,240 years. A number of areas of the Winkle surface in the Willamette Valley have strata of volcanic ash from the eruption of Mount Mazama.

The well drained Malabon and Jimbo soils are typical of soils that formed in sediment associated with the Winkle surface. This surface has been stable for a sufficient period of time for the Malabon soils (Pachic Ultic Argixerolls) to have developed a thick mollic epipedon with an organic matter profile resulting from pedogenesis rather than from organic matter deposited with the alluvial parent material. Malabon soils have been leached of bases to a base saturation of less than 75 percent since the early Holocene. Malabon soils are the youngest soils in the survey area that have sufficient clay illuviation to have an argillic horizon.

Malabon soils are in convex areas on the Winkle surface, and Coburg, Conser, and Clackamas soils are in the concave microrelief of the bar and channel topography. Coburg, Conser, and Clackamas soils show gleying and show the mobility of ferrous iron to form mottles.

Jimbo soils (Andic Haplumbrepts) have a dark colored umbric epipedon and a cambic horizon overlying very cobbly sand. The solum is thixotropic because of its content of weathered volcanic ash.

The Crutch soils (Haplorthods) have albic and spodic horizons over a brittle pan that is weakly cemented by silica. Crutch soils formed in late Pleistocene to early Holocene glacial outwash and alluvium. Carbon 14 dates obtained for the Winkle surface span the time of the eruption of Mount Mazama, so undoubtedly some volcanic ash is present in the Crutch soils. Acid leaching of coarse parent material by about 85 inches of precipitation under coniferous vegetation with acid litter has produced the prominent genetic horizons of the Crutch soils.

Champoeg surface.—The geomorphic episode that resulted in the construction of the Champoeg surface at the close of the Pleistocene severely modified remnants of the older surfaces. The Champoeg surface in the Willamette Valley is a relatively minor surface consisting of small pediment and dunelike landforms that grade to a base level that has remained stable for only a brief period of time.

In the Tualatin Valley and the Portland area, the geomorphic episode resulting in the Champoeg surface was an important event in the evolution of local soil landscapes. Field correlation relates the Champoeg surface to the Portland Sand and Gravel (*20, 22*). Deposits associated with the Champoeg surface in this area consist of torrentially cross-bedded gravel and cobbles with inclusions of large boulders, several of which are 8 to 10 feet in diameter. Foreset beds dip to the south, indicating that the source of the gravel was the Columbia River. It is probable the sediment was derived from the Missoula Flood (*1, 6*), because the times proposed for these catastrophic floods fit the geomorphic sequence and correspond to locally obtained Carbon 14 dates. Trimble (*32*) attributed the gravel to a catastrophic flood formed by the emptying of Lake Missoula in Montana into the Columbia River drainageway. Elevation of the Champoeg surface in Clackamas County commonly is 80 to 170 feet.

The outwash during the Champoeg episode truncated older surfaces in its path. This is evidenced by the asymmetry of Rocky Butte, Mount Tabor, and the remnant ridge of the Dolph surface immediately south of Wood Village in Multnomah County. The sand facies of the Portland Sand and Gravel is common as an eddy deposit in the Canby area, around Lake Oswego and extending west to the county line, and between Johnson Creek and the county line.

In the survey area, Multnomah soils (Dystric Xerochrepts) and Canby soils (Pachic Ultic Haploxerolls) have developed in material underlying the Champoeg surface. Development of an ochric or mollic epipedon and a cambic horizon with weak structure is the dominant evidence of soil development. The lithologic discontinuity at a depth of 38 inches in Multnomah soils that have a thin solum over a very gravelly sand substratum has facilitated the leaching of these soils to a base saturation of 24 to 39 percent in the solum; however, clay eluviated in the Multnomah soils would easily be translocated through the underlying gravel and below profile depth. There is some evidence of clay eluviation into the gravel, as evidenced by some clay coatings on the bottoms of pebbles.

Calapooyia, Senecal, and Senecal (rock floored) surfaces.—The Senecal surface in the Willamette Valley has been derived from minor incision, with integration of drainage of the Calapooyia surface, which is the main valley floor. Senecal microrelief may be as much as 6 feet at the heads of valleys hanging above Ingram. The stratigraphy of deposits associated with the Calapooyia and Senecal surfaces has been extensively studied in the southern part of the Willamette Valley (*8*). These deposits are considered to be silty and clayey sediments of Willamette Sound that were described as early as 1871 (*9*). Samples obtained from sediment beneath the Calapooyia and Senecal surfaces have been beyond reach of radiocarbon dating. In Clackamas County, mapped remnants of the Calapooyia surface occur only north of Aurora Airport. Typical soils on the Calapooyia surface are Dayton, Concord, and Amity soils; however, in Clackamas County, mostly Amity soils and a few small areas of Concord soils are in the area mapped as the Calapooyia surface.

In areas of the Calapooyia surface that are inclusions in areas mapped as the Senecal surface are Dayton, Concord, and Amity soils. Dayton and Concord soils also are in shallow channels in Senecal. The master horizons of Dayton soils (Typic Albaqualfs) and Concord soils (Typic Ochraqualfs) have been shown to consist of contrasting depositional strata of the Willamette Formation (*16*). The silty albic horizon of the Dayton and Concord soils is the Greenback Member, and the IIBt horizon is the Malpass Member—a clay. The Irish Bend

(formerly Willamette Silts) or the Wyatt Member, or both, commonly underlie the solum of the Dayton and Concord soils. The two series are distinquished by the thickness of the Malpass clay. The Dayton soils have a IIBt horizon more than 12 inches thick, and the Concord soils have a IIBt horizon less than 12 inches thick. Because the Greenback and Malpass deposits are not coextensive, the texture differences of the master horizons of Dayton and Concord soils are depositional rather than pedogenic. Features of the soils that are a result of soil formation include a small amount of organic matter (less than 1.5 percent), clay films, soil structure, and iron-manganese concretions formed across the lithologic discontinuities.

Amity soils occur in convex areas of the Calapooyia and Senecal surfaces. The stratigraphy of the master horizons is similar, but there is a notable absence of Malpass clay; therefore, the Greenback Member directly overlies the Irish Bend Member, and internal soil drainage is thereby improved from poorly drained to somewhat poorly drained. The better drainage has favored production of grasses; therefore, nutrient recycling has inhibited base leaching so that a mollic epipedon could form.

The Senecal episode is preserved as terrace remnants along major streams deeply incised below the former late Pleistocene valley floor. Elevations generally are in the range of 150 to 350 feet. The rock floored Senecal surface, a strath terrace, has soils similar to the ones on the Senecal surface as well as the Xerochrepts-Rock outcrop complex.

Typical soils of the Senecal surface are the Aloha, Woodburn, Willamette, Latourell, and Quatama soils. Latourell and Quatama soils have an ochric epipedon and exhibit a prominent agrillic horizon that formed under forest vegetation. Although these soils are texturally similar to the Multnomah soils, the profiles are thick enough to retain eluviated clay and form a distinct illuvial horizon. Leaching over time has been adequate to maintain a base saturation between 35 and 75 percent. Hence, these soils are Ultic or Aquultic Hapoxeralfs.

Woodburn and Willamette soils that formed under grass have a mollic epipedon, an argillic horizon, and a base saturation higher than that of Quatama and Latourell soils. Annual root dieback of grass incorporates organic matter into the soil. Under a grass dominated plant community, nutrient cycling of bases greatly inhibits base leaching, so an organic-matter- and base-rich mollic epipedon develops.

Aloha soils are in areas that have a low slope gradient and, combined with a slightly brittle, dense B horizon, are somewhat poorly drained and are classified in an Aquic subgroup. Although Aloha soils are classified as Xerochrepts, a few thin clay films are on peds and in pores of some pedons. The moderately slow permeability of these soils, resulting from the weak hardpan properties, tends to inhibit the eluviation of clay to form an argillic horizon. The slightly brittle horizons strongly resemble material of the Wyatt Member of the Willamette Formation. Huberly soils (Fragiochrepts) are in drainageways and are associated with Aloha soils.

Bethel surface.— The Bethel surface in the survey area is at elevations between 300 and 500 feet. The Bethel surface (*11*) is characterized by subdued, rolling hills with moderate relief and gentle slopes that generally grade to the Senecal surface. Summits of the wider hills are nearly level. This surface is mantled with Irish Bend silty and clayey sediments that onlap from the lower late Pleistocene surfaces of the main valley floor. This surface contains most of the glacial erratic boulders described by Allison (*2*) as having been ice-rafted into the Willamette Valley area. Alluvial toe slopes of valley side alluvium, probably of Holocene age, also help to blend the Bethel surface with the next lower surface. The Bethel surface is considered to be late Pleistocene.

The underlying structure of fault blocks and linear folds may have produced the initial step-sequence, along the Parrett-Chehalem Mountain anticline, with subsequent onlap of Pleistocene sediment. These blocks form the core upon which the Bethel and Dolph surfaces developed.

Helvetia soils (Ultic Argixerolls) and Powell soils (Typic Fragiochrepts) are extensive on the Bethel surface. Helvetia soils have a mollic epipedon, moderate grades of structure, and an argillic horizon and have been stable long enough to be somewhat depleted of bases for soils in an Ultic subgroup. Unlike other soils that formed in material derived from the Irish Bend Member, Helvetia soils do not have a pachic epipedon, probably as a result of the erosion of somewhat steeper slopes over a longer period of time.

Powell soils have an ochric epipedon, a cambic horizon, and a hardpan. As shown by Whittig et al. (*33*) in their mineralogic studies, Powell soils consist of two increments of silt separated by a weathering interval. The increments apparently correspond to the Greenback and Irish Bend Members of the Willamette Formation, described by Balster and Parsons. The hardpan in the Powell soils at a depth of 15 inches is in the position of an argillic horizon and could effectively restrict the illuviation of clay. Kinton soils are similar to Powell soils but have a thicker cambic horizon; hence, the hardpan is deeper so that the Kinton soils are better drained.

Cornelius soils (Mollic Fragixeralfs) are similar to Helvetia soils but have an ochric, rather than a mollic, epipedon and a hardpan. Cornelius soils formed under forest vegetation, and Helvetia soils formed under grass; these soils are probable members of a biosequence.

The argillic horizon of Cornelius soils is above the hardpan, but evidence of clay illuviation in Kinton, Powell, and Cascade soils is in the hardpan. The presence of an argillic horizon in Cornelius soils strongly suggests that they are geomorphically more stable than Kinton soils, which have only a cambic horizon. The

concept is partly substantiated in that Cornelius soils commonly are in higher lying or less sloping areas, or both.

Dolph surface.— The Dolph surface is next to the oldest group of landforms in the survey area. Topography of the Dolph surface varies, but it is well above the general level of the valley floors. The Dolph surface occurs as remnants of extensive flats that have been dissected to form a rolling topography composed of a complex group of landforms that could be further divided into terraces, pediments, and upland remnants for detailed study. The shoulders of valleys that grade to the Luckiamute surface, which is equivalent to the Ingram surface but is underlain by local alluvium, are included in the Dolph surface, while the back slopes, foot slopes, and alluvial toe slopes of small tributary valleys are included in the concept of the Luckiamute surface and its local alluvium. The Dolph surface may be underlain by bedrock, weathered gravel, saprolite, or clay deposits. The weathered loamy gravel under the Dolph surface in this area is derived from the Troutdale Formation, whereas further south in the Willamette Valley the deposits are the Lacomb and Leffler Gravels. The Dolph surface is considered to be middle Pleistocene because of its position on the landscape and the degree of weathering of the underlying material. Elevation commonly is 400 to 600 feet.

Typical soils on the Dolph surface in the survey area are Cornelius, Delena, Bornstedt, Borges, Sawtell, and Hardscrabble soils. The Cornelius soils have had some depletion of bases and have an argillic horizon above the hardpan as well as clay films in the hardpan. The greater thickness of the solum over the hardpan in Cornelius soils as contrasted with that of the Powell soils on the Bethel surface provides additional material above the pan into which clay can be illuviated. Cornelius soils have had a longer period of time to form, so the profile of these soils can be expected to exhibit stronger horizonation. Cornelius soils are also discussed in the section on the Bethel surface.

Bornstedt soils are Typic Haploxerults that have an ochric epipedon, a prominent argillic horizon, an increased clay content with depth, and base saturation that decreases with increasing depth to 27 percent. Bornstedt soils are on remnants of loess mantled alluvial terraces as evidenced by the silty textures above the lithologic discontinuity at a depth of 33 inches. The lower part of the solum is a Paleosol.

Hardscrabble soils (Aquic Palexeralfs) have an ochric epipedon and an upper part of the B horizon that formed in pedisediment (*31*). These soils have a clay argillic horizon that begins at a lithologic discontinuity, are somewhat poorly drained because of a periodically perched water table, and are prone to mass movement. The hummocky microrelief within old slump blocks indicates the unstable nature of some areas of Hardscrabble soils. Mass movement is more pronounced where areas of the Dolph surface were incised by younger geomorphic episodes. In areas of the Dolph surface with clay textures below a lithologic discontinuity, such as in Hardscrabble soils, features considered by the author to be littoral surge channels of Willamette Sound have been observed. These tide eroded clays could be the precursor for the Malpass clay (Dayton IIBt horizon) under the Calapooyia and Senecal geomorphic surfaces.

The Sawtell soils (Ultic Argixerolls) have a mollic epipedon and an argillic horizon, and they have formed in two gravel deposits. The lithologic discontinuity at a depth of 20 inches is indicated by a change from 25 percent unweathered coarse fragments in the B21 horizon to 40 percent partially weathered coarse fragments in the IIB22t horizon. Sawtell soils formed on the alluvial terrace landforms of the Dolph surface, probably in gravel equivalent to the Leffler Gravel, a middle Pleistocene glaciofluvial outwash material (*3*). Even though the Sawtell soils are quite old, nutrient cycling of bases and accumulation of organic matter by vegetation have been adequate to form and maintain a mollic epipedon. Geomorphic stability over time has been adequate for the development of an argillic horizon.

Eola surface.— The Eola surface consists of erosional remnants of the oldest stable geomorphic surface in the area. The crests and upper parts of Petes Mountain, Beaver Creek area, and Parrett Mountain are representative of the Eola surface. Relief of the Eola surface in the unit is moderate; typical remnants have rounded hill and valley topography with as much as 150 feet of local relief. Hanging valleys are common. Slope ranges from 2 to 20 percent, and elevation ranges from 450 to 1,500 feet, but most areas of the Eola surface are generally 600 to 800 feet.

The Eola surface is considered to be early Pleistocene and was undoubtedly quite extensive; however, late Pleistocene and Holocene erosion, as discussed previously, removed much of this surface so that only small remnants remain. Landforms of the Looney surface generally adjoin the Eola surface and join it to younger, lower lying surfaces. In northern Clackamas County, the Eola surface is overlain by an enigmatic silt reported to be loess (*21*) that in some places contains erratic gravel and cobbles. Thickness of the silty mantle ranges from 78 to 130 inches on stable summits of the Eola surface but decreases to 0 within as little as 4 air miles to the southwest. This material would more properly be called Portland Hills Silt (*13*) or Upland Silt (*20*) than loess. The Portland Hills Silt typically contains 19 percent sand, 64 percent silt, and 17 percent clay. These silts overlie bedrock, saprolite, or a reddish Paleosol, perhaps the Diamond Hill Paleosol, that may be the precursor of Cazadero and Jory soils.

The Eola surface in Clackamas County is typified by Cazadero, Saum, Jory, and Cascade soils. Cazadero and

Jory soils are Ultisols; therefore, they represent the most advanced stage of weathering and leaching of bases in the survey area. Studies of soils of the Eola surface have shown that deep, red soils with a prominent argillic horizon are primarily on stable ridgetops and pediment remnants (*15, 18*). Saum soils (Typic Xerumbrepts) are shallower than Cazadero soils, and are eroded remnants on metastable side slopes (*19*); the solum is 23 inches thick and developed in pedisediment overlying the truncated remnants of a Paleosol.

Cascade soils (Typic Fragiumbrepts) formed in Portland Hills Silt and in many places overlie a buried Paleosol. Soil-stratigraphic relationships indicate that th ; Cazadero soils and similar Ultisols are relict Paleosols that are probably equivalent to the Diamond Hill Paleosol or the Helvetia Formation, which may be the same Paleosol. The Cascade soils may contain several discontinuities based on mineralogic and stratigraphic evidence; in some places, they have two hardpans superimposed within an angular unconformity. Cascade soils may be the higher elevation equivalents of Powell soils. Soil development in Cascade soils has been restricted by the presence of a relatively impermeable hardpan and by erosion.

Laurelwood soils (Ultic Haploxeralfs) and Cascade soils are at similar elevations on the Eola geomorphic surface, and both formed in Portland Hills Silt; however, Laurelwood soils have an argillic horizon and no hardpan. The reason for the developmental difference is not known. The lower part of the argillic horizon in the Laurelwood soils may be inherited from the underlying red Paleosol without an intervening hardpan. Mineralogic and soil-stratigraphic studies of the soils, Portland Hills Silt, and depth to and nature of the Paleosols would resolve the issue. Other soils associated with the Eola geomorphic surface are Cottrell, Nekia, and Alspaugh soils.

Looney unit.—The Looney unit as mapped has no particular age connotation and, therefore, is not considered a geomorphic surface. The terrain of the Looney unit is completely dissected and is predominantly steeply sloping. Slope gradients may exceed 100 percent. Steep, broken topography mapped as the Looney unit may join any other two surfaces, or it may make up large areas of mountainous terrain so thoroughly dissected that it contains no recognizable geomorphic surfaces. Erosion is active on much of the Looney unit, with some areas of mass movement. There are, however, occasional remnants of some of the oldest geomorphic surfaces in the area.

The variability in age makes the Looney unit a useful unit for mapping areas of mountainous terrain. The Looney unit could be subdivided into several smaller geomorphic units if it were mapped at a larger scale. Three significant gradient breaks are apparent, and they correspond to stable, metastable, and active slopes. Valley floors and small alluvial cones are Luckiamute inclusions in the Looney unit. The soils in these areas formed in colluvium and glacial till derived from andesite and basalt and are mixed with volcanic ash.

Soils representative of the Looney unit in the western part of Clackamas County are Saum and Witzel soils. Saum soils (Typic Xerumbrepts) have an umbric epipedon and a cambic horizon, are deep over bedrock, and have steep metastable slopes. The presence of a lithologic discontinuity at a depth of about 26 inches is substantiated by an increase in content of coarse fragments from 5 percent in the B2 horizon to 30 percent in the IIB3 horizon. The soil material above the discontinuity is slope alluvium, and the IIB3 and IIC horizons are remnants of Paleosols.

Witzel soils (Lithic Haploxerolls) have a mollic epipedon and a cambic horizon, are about 16 inches deep to fractured basalt, and are on geomorphically active slopes. The lithologic discontinuity at a depth of about 16 inches is documented by the lack of B3 and C horizons and an abrupt boundary between the solum and bedrock. Other soils occurring in the mesic area on the Looney unit are mostly Haplumbrepts such as Kinney and Aschoff soils, Xerochrepts and Haploxerolls, and Dystrochrepts, very steep. Bull Run soils have a high content of volcanic ash and are Vitrandepts. Frigid soils in the Cascade Range part of the survey area include Fernwood, Wilhoit, Zygore, and Memaloose soils, which are Haplumbrepts and Dystrochrepts; Newanna, Divers, Highcamp, Kinzel, Soosap, and Talapas soils, which are Cryochrepts and Cryumbrepts; and Lastance and Thader soils, which are Cryorthods.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles larger than 2 millimeters in diameter.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Very cobbly soil material is 35 to 60 percent of these rock fragments, and extremely cobbly soil material is more than 60 percent.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently

ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature; for example, fire that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hanging valley. A valley that lies above a point of abrupt inflection in the longitudinal profile of a stream.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.
A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.
B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.
C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.
R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation (sprinkler). Water is sprayed over the soil surface through pipes or nozzles from a pressure system to assist in production of crops.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Open space. A relatively undeveloped green or wooded area provided mainly within an urban area to minimize feelings of congested living.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0

Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Saprolite (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell (in tables). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material

that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 6 to 15 inches (15 to 38 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer, " or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse, " "fine, " or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Third order valley. A valley produced by a third order stream. In a drainageway network, the smallest unbranched tributaries are designated order one, the confluence of two first order streams produces a second order stream, the confluence of two second order streams produces a third order stream, and so on.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Tuff. A compacted deposit that is 50 percent or more volcanic ash and dust.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water bars. Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much

that it does not recover when placed in a humid, dark chamber.

Windthrow. The action of uprooting and tipping over trees by the wind.

End Roll

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